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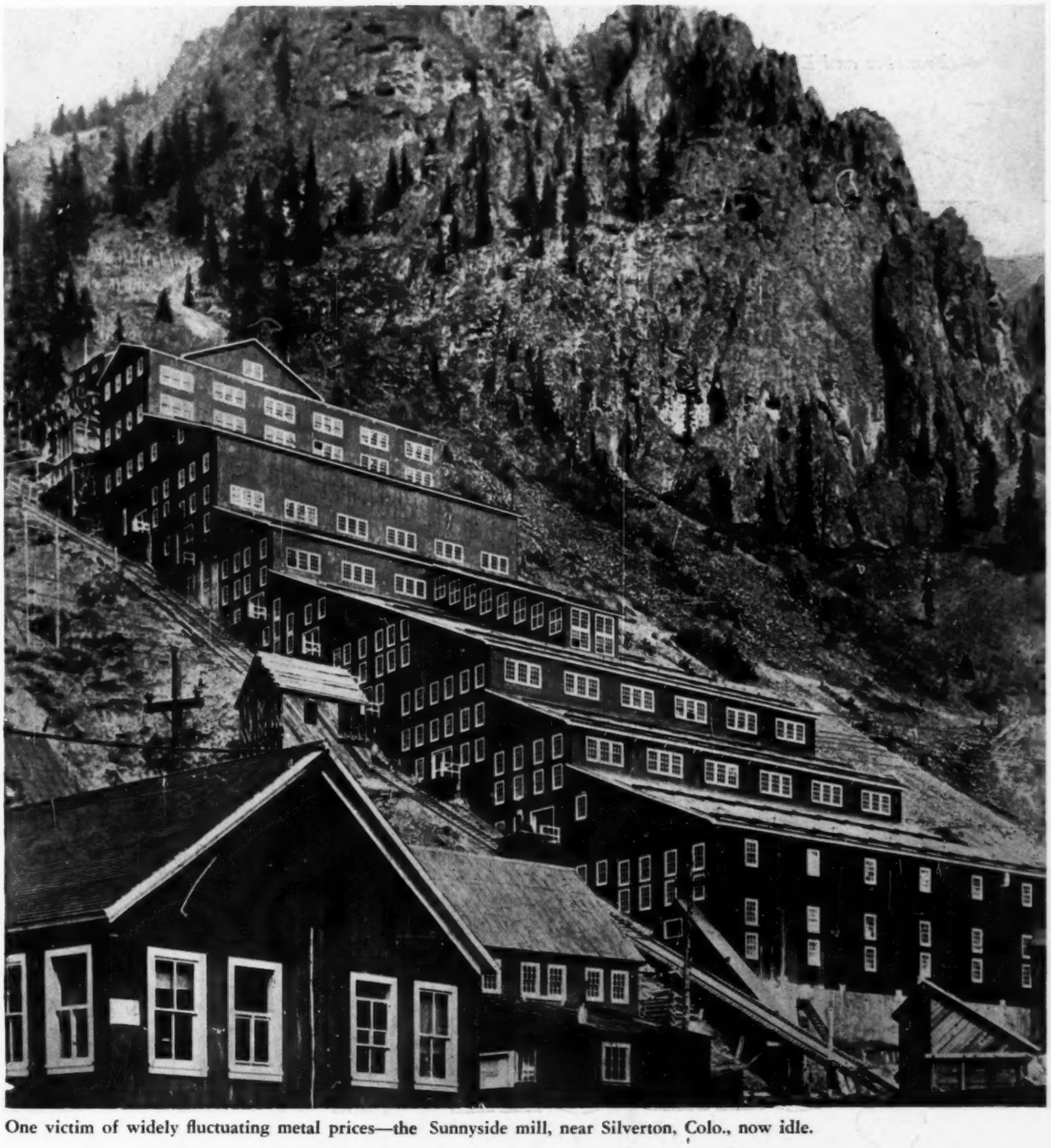

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January 26, 1931

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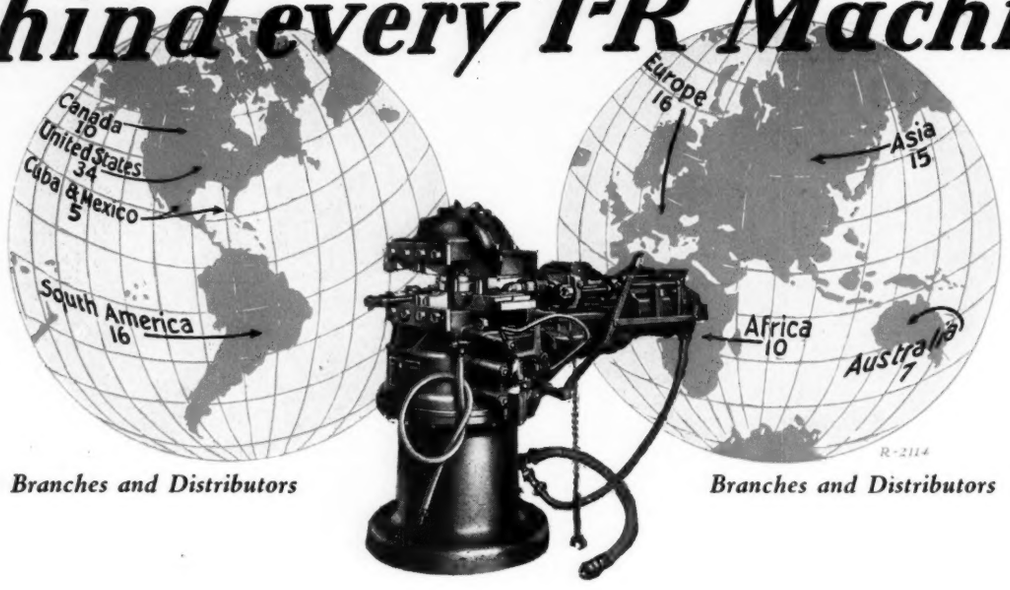

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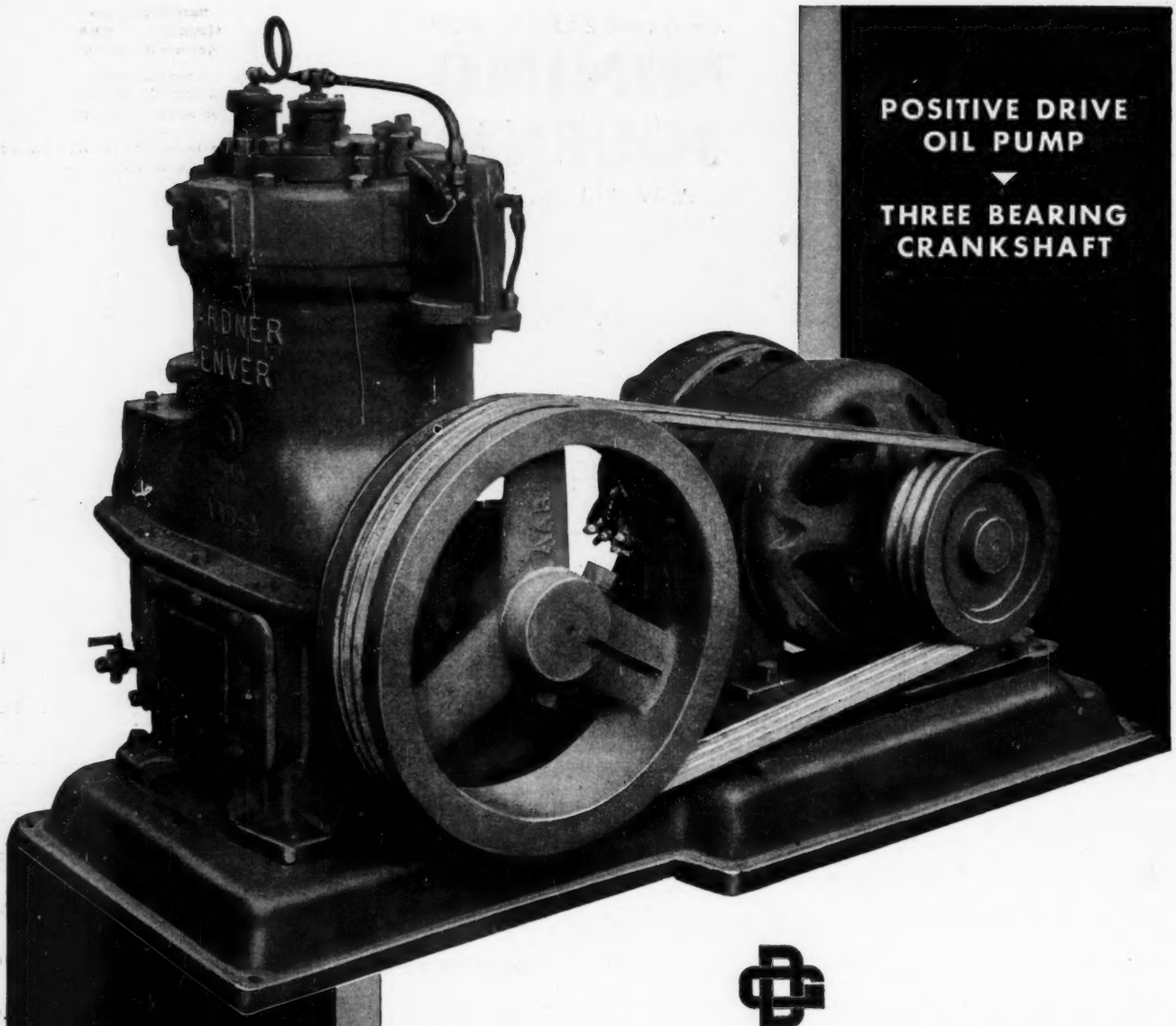

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ENGINEERING AND
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A. W. ALLEN, *Editor*

ESTABLISHED 1866

VOLUME 131, No. 2

New York, January 26, 1931

China and the Silver Standard

NATIONS anxious to do business with China adhere to the gold standard in their own financial affairs, expecting China meanwhile to absorb the world's surplus of silver, elsewhere considered only as a commodity. Expressed concern at economic conditions in China does not strike a responsive chord in that country, according to Mr. Tsuyee Pei, managing director of the Bank of China at Shanghai, who recently addressed the New York section of the American Institute of Mining and Metallurgical Engineers, and who stated that "Americans are paying dearly in their efforts to uphold the prestige of gold as the only standard of value."

China, Mr. Pei maintained, is not so badly off as many people suppose. Depreciation in commodity prices there has been much less severe than in gold-standard countries. China's major comment on the existing economic situation is that the world price of silver is so low that too much of the metal is needed to cover a unit international transaction, to the detriment of her import trade. Recent heavy declines in the price of silver may be attributed in part at least to heavy selling of silver by China, to purchase gold exchange wherewith to meet payments for imports. In addition, large sales of silver by the government of India have aggravated a situation that calls for international co-operation. China has absorbed increasing amounts of silver in recent years. Mr. Pei intimates that his country is not seeking a loan of silver, believing that such borrowing would not be to her interest.

Beneath the characteristic courtesy of the Chinese, and with a recollection of the cultural history and traditions of that great country, of the moral and intellectual honesty of the race, one senses a gentle impatience that their leaders in thought and action are not consulted in regard to plans proposed by the nationals of other countries, plans that would, if consummated, affect the Chinese national economy. "The world," Mr. Pei reminded his hearers, "is undergoing a trying time in attempting to dissociate silver from gold and classing it simply as a commodity. If success in that direction be achieved, we, our sons and grandsons must be prepared to meet whatever consequences may befall, such as recurrent business depressions, economic crises, dislocation of gold values, and probably a general collapse of the credit system. Silver needs rehabilitation," he avers. "The method is simple, but first of all we must recognize the real causes of the present collapse of prices."

Collection and classification of facts and data are of essential importance. Reason and intelligence must be applied in an effort to discard what is biased and non-essential, or dictated solely by self-interest; and in this study the help should be sought of those who use and understand the function of silver as a monetary standard. Finally, sincerity is the best lubricant to insure smooth international relations, on which depends to a considerable extent a solution of the silver problem.

Central Milling and the Future of the Tri-State District

MANY engineering projects, particularly those involving a departure from common practice, are subject during the period of their inception to severe and searching criticism, even to the extent of their failure being forecast. Consequently the task of bringing such enterprises to completion is invariably attended by much trial for the sponsors. Few such works, however. owe their inception and execution almost entirely to the vision and tenacity of purpose of one individual, as does the Bird Dog central milling plant, described elsewhere in this issue. This achievement, mentioned with fitting modesty by Mr. Elmer Isern in his article, is undoubtedly the forerunner of a new era in the mining and milling of Tri-State zinc-lead ores. The advantages gained by such centralized procedure would seem to make the general adoption of large-scale operations inevitable in the district. In fact, the ability of the Tri-State mining industry to compete satisfactorily in the near future with Western producers will probably be contingent on the general application of central milling.

In addition to the fact that centralized operations at the Bird Dog plant have effected a 41.5 per cent increase in the amount of ore milled per man-shift, compared with the average for the other mills of the Commerce Mining & Royalty Company, Mr. Isern points out in a private communication that the district has many characteristics which make the general application of central milling advisable. Climatic conditions, for instance, are almost ideal for continuous operations; topographic features favor the use of surface haulage systems; labor is intelligent and efficient. Moreover, the ore-bodies are at a depth of only 300 ft., which circumstance, together with other favorable conditions underground, results in a low mining cost.

Central milling, besides providing low-cost surface operations comparable with those that Nature has made possible underground, presents to the Tri-State district an opportunity to regain its former position as one of the keenest competitors in the zinc-mining industry.

Eliminating a Nuisance Increases Earnings

MONEY expended to remedy unsatisfactory working conditions is usually well invested other than from a humanitarian point of view; it may add safety and increase efficiency, as well as reduce waste. For example, one plant operator, faced with an annoying condition caused by excessive dusting, placed light and inexpensive hoods over all equipment from which the escape of dust was unpreventable, such as mills for dry grinding, screens, and bins. The hoods were connected to a baghouse, a fan being used to maintain a slight suction. In addition to reducing personal discomfort, unaccountable losses were lowered so much that the installation soon proved a financially profitable investment.

Intelligent use of rubber has remedied many an unsatisfactory operating condition, with resultant financial return to the company. Rapid strides have been made in the technique of its manufacture and application in recent years, so that products with a wide variety of physical characteristics are now available to meet many different contingencies. Rubber-covered metal; rubber-lined bearings, pipes, and tanks; rubber with high resistance to the corrosive action of chemicals and acids, mineral as well as organic; vulcanized rubber of great strength that may be worked like lumber—these are some of the developments that are aiding in overcoming the nuisance and loss involved by vibration, abrasion, corrosion.

Much of the discomfort from excessive heat suffered by men working near boilers and metallurgical furnaces can be avoided by proper insulation of the equipment with one of many excellent materials now available. At one metallurgical plant, recently constructed, heat is conserved and the furnace crew relieved of distress by insulating the Wedge roasters. A material saving in fuel consumption can thus usually be made by a manager whose attention is perhaps first directed to the opportunity for reform by complaints about unpleasant working conditions.

American Business and the Depression

ATTEMPTS to assess the cause and to fix the responsibility for the prevailing industrial depression have been legion. Newspapers, Sunday supplements, reviews and magazines of fact and fiction, financial and otherwise, have generously given of their space to a vast army of writers with opinions and views. "The Guaranty Survey" for December, issued by the Guaranty Trust Company of New York, indicates the result of wide reading, and is supplemented by caustic criticism of the policies of American business, coupled with warnings.

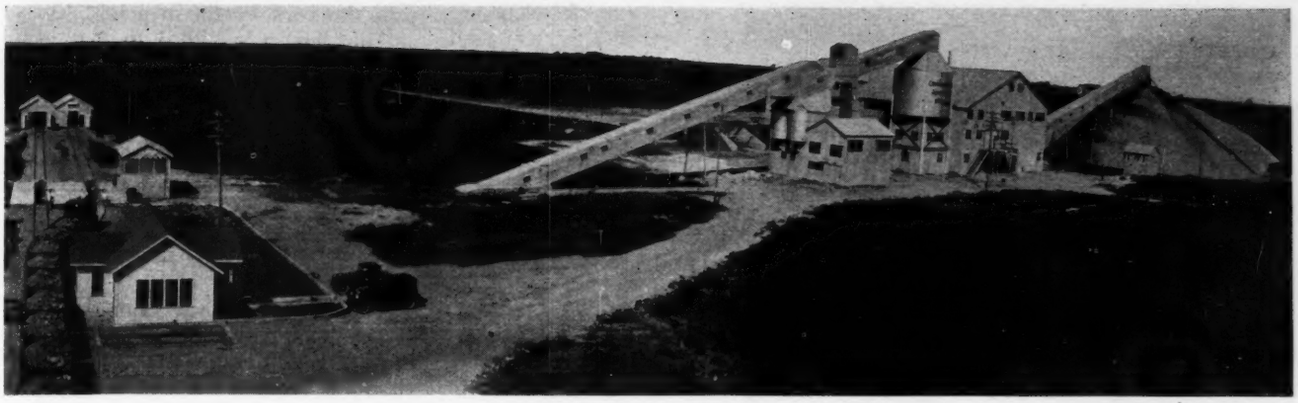
Business cycles, the "Survey" maintains, "while by no means absolutely periodic, are regular enough to suggest very strongly that their causes lie principally within the normal business cycle itself, and not in such extraneous factors as wars, revolutions, legislative enactments, and natural catastrophies." Business, the industrialist will read with chastened spirit, "has earned no immunity from the effects of excesses and bad management and the natural operation of economic law." And among conclusions reached by the "Survey" is one to the effect that "depressions have their origin in the preceding periods of over-expansion and inflation which are falsely termed prosperity, and that little progress can be made in avoiding these upheavals until business becomes sufficiently well organized, far sighted, and wise to forego the tempting possibilities that always present themselves in prosperous times."

Business may have been seduced by tempting possibilities, but is the banker entirely free from responsibility? In a subsequent section of the "Survey," under "features of the financial situation," one reads that " 'bootleg' loans to brokers on stock-market collateral—that is, loans made for account of outside lenders"—reached the astounding total of $3,941,000,000 in October, 1928. The unhappy events of the year that followed forced a reduction in the amount to $1,804,000,000 by December, 1929; and last month the total was still further reduced to $430,000,000. Although such sums may represent a mere bagatelle in high finance, they indicate to the layman a profound change in the financial policies of the leading banking houses, which may, or may not, have been due to a failure to forego indulgence in "tempting possibilities that always present themselves in prosperous times," for which American business is asked to accept full responsibility.

Amalgamation in Treating Refractory Gold Ore

ADVICES from Johannesburg indicate the successful outcome, on a laboratory scale, of a new method for the recovery of gold from the stibnite ores of the Murchison Range, in which process amalgamation plays an important rôle. A concentrated product shows no free gold. After roasting in contact with a mixture of chemicals obtained as by-products of a local industry, however, bright gold is liberated, which can be readily amalgamated. The tailing after amalgamation is treated for the recovery of antimony, either as oxide or metal. By the new process, which is sponsored by Ferro-Alloy Proprietary, Ltd., recoveries of 90 and 80 per cent of gold and antimony, respectively, are said to be feasible. A continuous-process pilot plant is being designed, where the laboratory development can be extended and applied on at least a semi-commercial scale.

The association of arsenic with antimony has been partly responsible for the difficulty in treating gold-stibnite ores. Straight cyanidation invariably failed. Cyanidation after roasting gave low recoveries. A process involving the volatilization of the antimony promised success, but results failed to meet expectations. Flotation of a complex ore of this character has given excellent results, but such concentration is merely the preliminary phase of a recovery operation. The new process promises a high recovery of gold by a simple mechanical method, after a metallurgical roast. If successful on an operating scale, more attention will be deflected to an improvement in the technique of the old process of amalgamation as a working metallurgical tool.



The Bird Dog mill

Central Milling In the Tri-State District

Elmer Isern

TRADITION, reputedly, is the enemy of progress. The accuracy of this oft-quoted statement is well borne out by the history of the mining industry in the Tri-State zinc-lead district, where, until recently, operations have been on a comparatively small individual scale. During the last few years, however, the advance made in the application of new technical knowledge has been exceptional, and the influence of tradition is rapidly disappearing. One of the outstanding phases of this change is the trend toward central milling — a trend initiated by the author, who is the metallurgical engineer of the Commerce Mining & Royalty Company, at Miami, Oklahoma.

•

IN THE western part of the Kansas-Oklahoma section of the Tri-State zinc-lead district, the holdings of the Commerce Mining & Royalty Company include about 4,000 acres, on which are twelve mills, all within a radius of about three miles. Construction of a central milling plant, where the entire ore output of the company's various mines would be milled, seemed to me to be a logical step in achieving lower operation costs, as well as improved metallurgical efficiency—two objectives that have become of increasing importance in the district as the selling price of concentrate has declined. Accordingly, in 1927, after a thorough investigation of its possibilities, I submitted to the company a central milling plan, which indicated a saving in one year that exceeded the estimated cost of the central plant. From a tonnage standpoint, the project, as compared with operations in many other districts, was not unusual, the proposed milling rate being 4,000 tons in 24 hours.

The aforesaid acreage was all leased land, and, for the execution of the central milling plan, a complete revision of the leases and the consent of the numerous lessors to the plan were required. Moreover, the twelve small mills operating ten hours per day would be discarded for the one central mill operating 24 hours. These two factors —the probable difficulty of convincing lessors that their royalties would be accurately determined, which royalties are based on the sales of concentrate produced from ore mined on their respective land, and the scrapping of the twelve small mills—led to the rejection of the plan although its merit from a metallurgical, as well as an economic, standpoint was recognized.

About a year later the company decided to start production from three adjoining tracts of land, comprising 520 acres, known as the Meh-hunk-kah-zhe-kah, Little Greenback, and Wesa Greenback allotments, each allotment being restricted Indian land administered by the federal government, which acts in the capacity of a guardian to restricted Indians and their heirs. The central milling plan was revived, and new leases were prepared that specified milling at a central plant of the ore mined from the three allotments. These leases were submitted to the local federal Indian Agency, together with detailed information concerning the sampling system that would be employed to insure accurate determination of the royalties due the lessors of each allotment. On the recommendation of C. F. Williams, district mining supervisor, U. S. Geological Survey, these leases were approved by the Secretary of the Interior, in March, 1929.

Design of the central mill, to have a capacity of 100 tons of ore per hour, was begun immediately, and in June I submitted a report to the company that set forth in detail the entire plan, including a general description of the mill and equipment, flow sheet, cost estimate, and working drawings. Authorization to proceeed with the project was announced a few days later. Construction contracts were let, machinery was purchased, and actual erection of the mill, to be known as the Bird Dog mill, was started in July. The plant was completed in June, 1930, at a cost of $305,944.02; the estimated cost, as mentioned in the report of June, 1929, was $302,857.76, or, in other words, the actual cost exceeded the estimated by only 1 per cent. A summary, condens-

Fig. 1—Sketch on aerial mosaic map showing the three allotments and central milling plant

ing the 48 construction accounts into ten items, together with their total amounts that comprise, collectively, the actual cost of $305,944.02, is presented in Table I, on the opposite page.

The three allotments and the position of the mill, hoppers, and railroad are shown in outline on the aërial mosaic reproduced in Fig. 1. Selection of the mill site was made following the preparation and study of a detailed topographic map of the allotments that included 1-ft. contours. The site, as finally determined, provided (1) a central situation for the mill, (2) falling grades toward the mill for loaded trains traveling over the railroad, (3) suitable topography for the construction of an adjoining mill water supply pond, (4) ample space for the disposal of tailing produced in the milling operations.

Following the sinking of the four shafts, Nos. 11, 14, 24 and 31, each was equipped with a steel hopper and derrick (hoist), as shown in Fig. 2. The hopper is cylindrical in shape and has a cone bottom, center discharge, and a specially designed air-operated chute gate. Rapid, lengthwise loading of cars, with minimum spillage, is possible, inasmuch as the haulage line, in each instance, passes underneath the hopper. Ten cars, each holding 10 tons, can be loaded in 4½ minutes. The derricks are equipped for bucket-hoisting operations, which are commonly employed throughout the district.

The railroad is 2.3 miles in length and 42-in. gage. It consists of 35-lb. rail spiked to 6x6x8-in. hewed oak ties, spaced 2 ft. on centers. From the field hoppers the ore is transported to subsurface hoppers at the mill in 10-ton Sanford-Day automatic drop-bottom cars, hauled in trains of ten cars by a 14-ton Whitcomb gasoline locomotive, as shown in Fig. 2. On passing the mill office building, which adjoins the subsurface hoppers, the train passes over a 30-ton Howe track scales, and the weight of the ore in the cars is automatically recorded on a tape by a Streeter-Amet weighing and recording attachment. A clerk in the office enters on the tape the date and the number of the shaft (or allotment) whence the ore came.

Beyond the office building, the railroad line passes directly above the four 200-ton subsurface hoppers, each of which is equipped with a tripping device that is actuated from the office. A hopper is assigned to each of the three allotments. Ore from any one allotment is automatically dumped from the cars by the tripping device into the hopper assigned to that particular allotment. The chutes of these hoppers, as shown in the flow sheet in Fig. 3, discharge onto a 36-in. steel pan conveyor, made by the Pittsburg Boiler Works. From the conveyor the ore passes to a 30-in. Rogers crusher, with a 4-in. discharge opening. The crusher, shown in Fig. 4, discharges onto a 24-in. conveyor, which consists of 750 ft. of 6-ply Giant belting, made by the U. S. Rubber Company, on Stearns idlers. A view of this conveyor in operation is shown in Fig. 5. The four hoppers, crusher room, and the subsurface portion of the conveyor gallery are of reinforced concrete construction. An automatic American-Marsh sump pump removes seepage water. All electrical conduits and water pipes were set in the concrete during construction. The conveyor, which discharges into the mill hopper, passes, en route, over a tripper pulley, where the ore falls through an automatic sampling device and a representative sample is periodically taken for treatment in the sampling mill.

Accurate sampling, as well as accurate weighing, of the ore from the several allotments is the essential feature of the entire central milling project. To treat simultaneously in a single mill ore from more than one allotment was without precedent in the district and considered impossible from both the standpoint of economy and that of royalty settlement. Consequently, much thought was devoted to this phase of the project.

In designing the sampling equipment at the head of the plant, the following conditions were imposed: (1) a separate bin was required at the sampling mill for each of the four subsurface hoppers; (2) flow of ore into any one of the four bins had to be dependent on the drawing of ore from a complementary subsurface hopper; for instance, when ore was drawn from subsurface hopper No. 1, the sample cut out of the stream of crushed ore on the main conveyor had to go to No. 1 bin; (3) a time interval was necessary between the closing of the gate of one hopper and the opening of the gate of another; (4) to open the gate of more than one hopper at a time was to be impossible; (5) the control mechanism governing these operations had to be foolproof and reliable.

Several years ago I designed a compressed-air automatic sampler. This

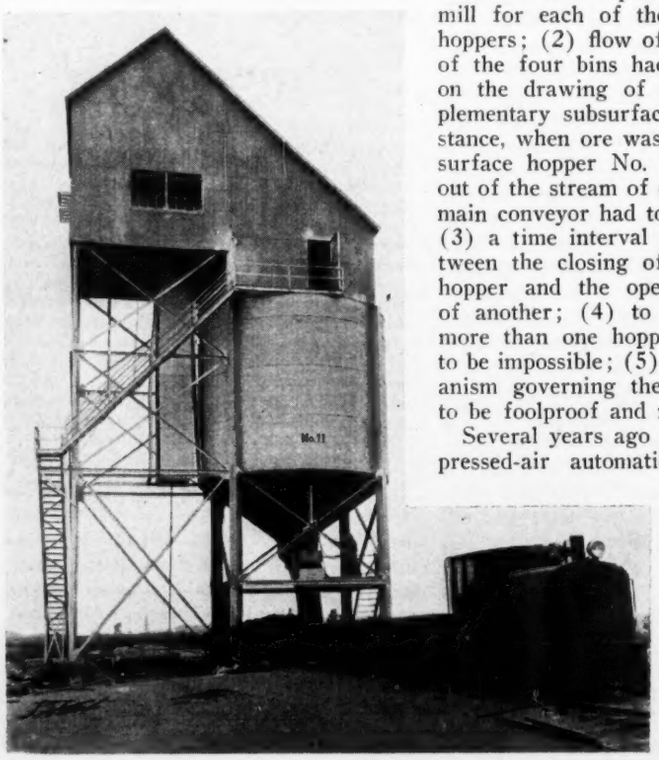
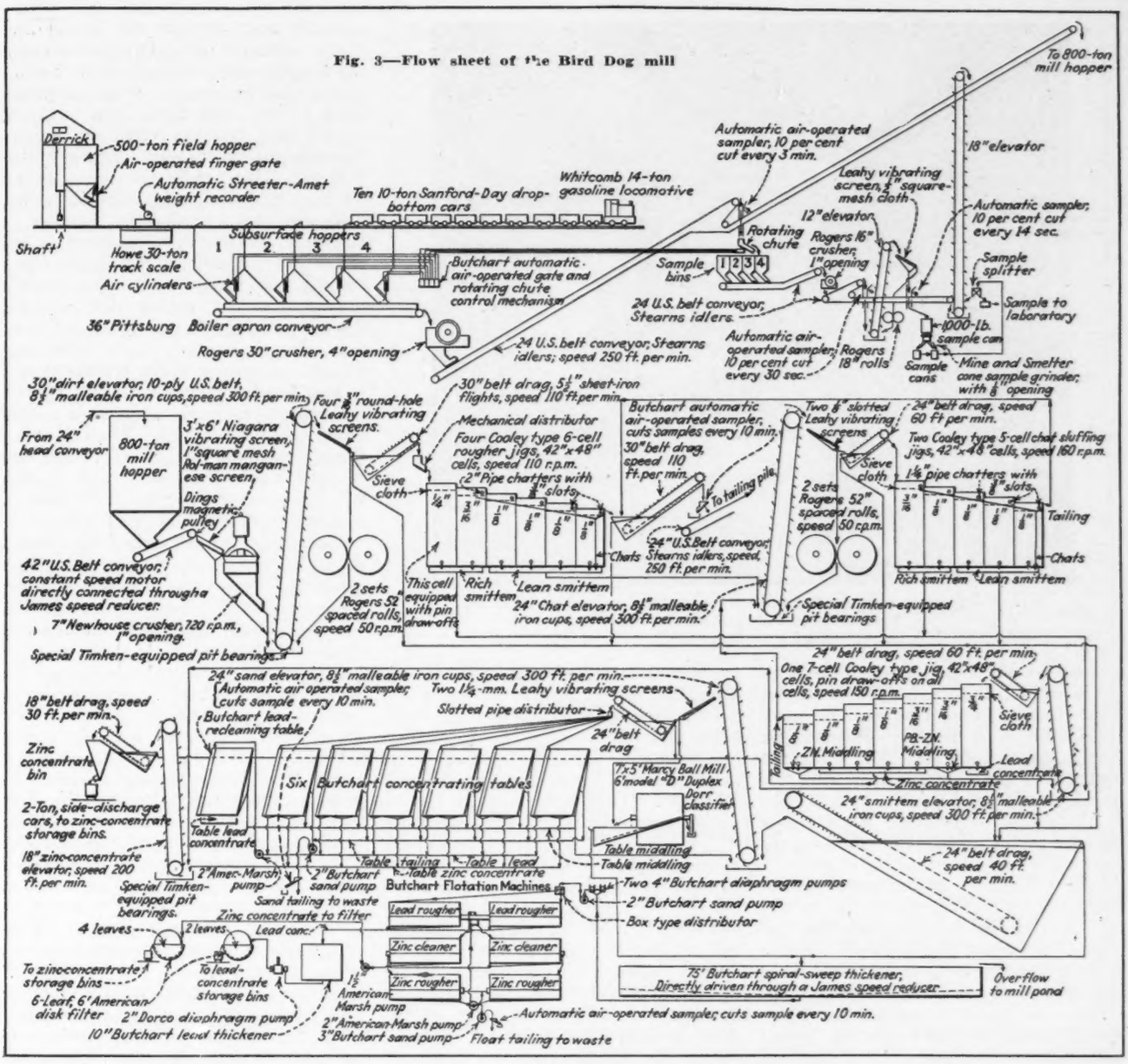


Fig. 2 Ore train under one of the field hoppers

Fig. 3—Flow sheet of the Bird Dog mill


To 800-ton mill hopper
Derrick
500-ton field hopper
Air-operated finger gate
Automatic Streeter-Amet weight recorder
Ten 10-ton Sanford-Day drop-bottom cars
Whitcomb 14-ton gasoline locomotive
Automatic air-operated sampler, 10 per cent cut every 3 min.
18" elevator
Leahy vibrating screen, 3" square-mesh cloth
12" elevator
Automatic sampler, 10 per cent cut every 14 sec.
Rotating chute
Rogers 16" crusher, 1" opening
Sample splitter
Shaft
Subsurface hoppers
Howe 30-ton track scale
Air cylinders
Butchart automatic air-operated gate and rotating chute control mechanism
Sample bins
24 U.S. belt conveyor, Stearns idlers
Sample to laboratory
36" Pittsburg Boiler apron conveyor
Rogers 30" crusher, 4" opening
24 U.S. belt conveyor, Stearns idlers; speed 250 ft. per min.
Automatic air-operated sampler, 10 per cent cut every 30 sec.
Rogers 18" rolls
1000-lb. sample can
Sample cans
Mine and Smelter cone sample grinder, with 1/8" opening
30" dirt elevator, 10-ply U.S. belt, 8 1/2" malleable iron cups, speed 300 ft. per min.
Four 3/8" round-hole Leahy vibrating screens.
30" belt drag, 5 1/2" sheet-iron flights, speed 110 ft. per min.
Mechanical distributor
Four Cooley type 6-cell rougher jigs, 42"x48" cells, speed 110 r.p.m.
Butchart automatic air-operated sampler, cuts samples every 10 min.
30" belt drag, speed 110 ft. per min.
Two 3/8" slotted Leahy vibrating screens
24" belt drag, speed 60 ft. per min.
Two Cooley type 5-cell chat stuffing jigs, 42"x48" cells, speed 160 r.p.m.
From 24" head conveyor
800-ton mill hopper
3'x6' Niagara vibrating screen, 1" square mesh Pal-man manganese screen
Dings magnetic pulley
Sieve cloth
2" Pipe chatters with 3/8" slots
To tailing pile
2 sets Rogers 52" spaced rolls, speed 50 r.p.m.
1 1/4" pipe chatters with 3/8" slots
Tailing
42" U.S. Belt conveyor, constant speed motor directly connected through a James speed reducer
2 sets Rogers 52" spaced rolls, speed 50 r.p.m.
This cell equipped with pin draw-offs
Rich smittem
Lean smittem
24" U.S. Belt conveyor, Stearns idlers, speed, 250 ft. per min.
Chats
24" Chat elevator, 8 1/2" malleable iron cups, speed 300 ft. per min.
Special Timken-equipped pit bearings
7" Newhouse crusher, 720 r.p.m., 1" opening.
Special Timken-equipped pit bearings
24" belt drag, speed 60 ft. per min.
24" sand elevator, 8 1/2" malleable iron cups, speed 300 ft. per min.
Automatic air operated sampler; cuts sample every 10 min.
Two 1/4-mm. Leahy vibrating screens
One 7-cell Cooley type jig, 42"x48" cells, pin draw-offs on all cells, speed 150 r.p.m.
18" belt drag, speed 30 ft. per min.
Butchart lead-recleaning table
Slotted pipe distributor
24" belt drag
Sieve cloth
Zinc concentrate bin
Six Butchart concentrating tables
7'x5' Marcy Ball Mill
6' model "D" Duplex Dorr classifier
Pb.-Zn. Middling
Zn. Middling
Tailing
Lead concentrate
Zinc concentrate
2-Ton, side-discharge cars, to zinc-concentrate storage bins.
Table lead concentrate
24" smittem elevator, 8 1/2" malleable iron cups, speed 300 ft. per min.
18" zinc-concentrate elevator, speed 200 ft. per min.
2" Amec-Marsh pump
2" Butchart sand pump
Table tailing
Table lead
Table zinc concentrate
Butchart Flotation Machines
Table middling
Table middling
24" belt drag, speed 40 ft. per min.
Special Timken-equipped pit bearings.
Sand tailing to waste
Two 4" Butchart diaphragm pumps
2" Butchart sand pump
Box type distributor
Zinc concentrate to filter
Lead rougher
Lead rougher
4 leaves
2 leaves
Lead conc.
Zinc cleaner
Zinc cleaner
To zinc-concentrate storage bins
To lead-concentrate storage bins
Zinc rougher
Zinc rougher
1 1/2" American Marsh pump
75' Butchart spiral-sweep thickener, Directly driven through a James speed reducer
Overflow to mill pond
6-Leaf, 6' American disk filter
2" Dorco diaphragm pump
10" Butchart lead thickener
2" American-Marsh pump
3" Butchart sand pump
Automatic air-operated sampler; cuts sample every 10 min.
Float tailing to waste

device, perfected by the W. A. Butchart Manufacturing Company, was employed as the head sampling unit on the main conveyor. The timing mechanism and the drive for the device are connected to the shaft of the upper conveyor pulley by sprockets and a chain. This arrangement insures a positive drive, the device being operated only when the conveyor is moving. Actual cutting of the sample is performed by a gate that deflects the ore either to a rotatable chute leading to the four bins above the sampling mill or back to the conveyor belt. The gate is operated by two cylinders placed end to end, the two pistons being on each end of a common shaft. Gear teeth on the shaft mesh with a quadrant section of a gear fastened to the pivot shaft of the gate. Direction of movement of the gate depends on the entry of air into the opposing cylinders. The timer is designed so that a 10 per cent sample of the entire ore stream is taken every three minutes. From this automatic sampler, the sample passes by gravity to the rotatable chute, as shown in the flow sheet at the top of this page.

Inasmuch as pneumatic samplers were to be employed in the main and sampling mills, a compressed-air operated mechanism seemed preferable for operating in unison the gates at the subsurface hoppers and the rotatable chute leading to the bins above the sampling mill. After several months of experimentation a suitable control mechanism, which will be described in detail in a subsequent issue, was evolved by the W. A. Butchart Manufacturing Company. As indicated in the aforesaid flow sheet, each of the four gates on the four subsurface hoppers is equipped with an air cylinder for raising and lowering the gate. The rotatable chute above the four bins at the sampling mill is operated by a series of four cylinders. Gate No. 1 is con-

Table I—Summary of Construction Cost Items

Item	Amount
Subsurface hopper, complete with machinery	$22,491.43
Head conveyor, complete with machinery	10,503.63
Sampling mill, complete with machinery and sampling equipment, including automatic gate mechanisms	16,468.32
Mill proper, complete with hopper, all machinery, tailing conveyor, concentrate bin, and transformers	163,266.08
Surface railroad and equipment	27,857.69
Dam and spillway	1,693.50
Four field hoppers, complete with hoisting equipment	38,970.04
Office, scales, miscellaneous equipment, painting, and superintendence	11,775.74
Blacksmith shop	496.13
Deep-well system	12,421.46
Total	$305,944.02

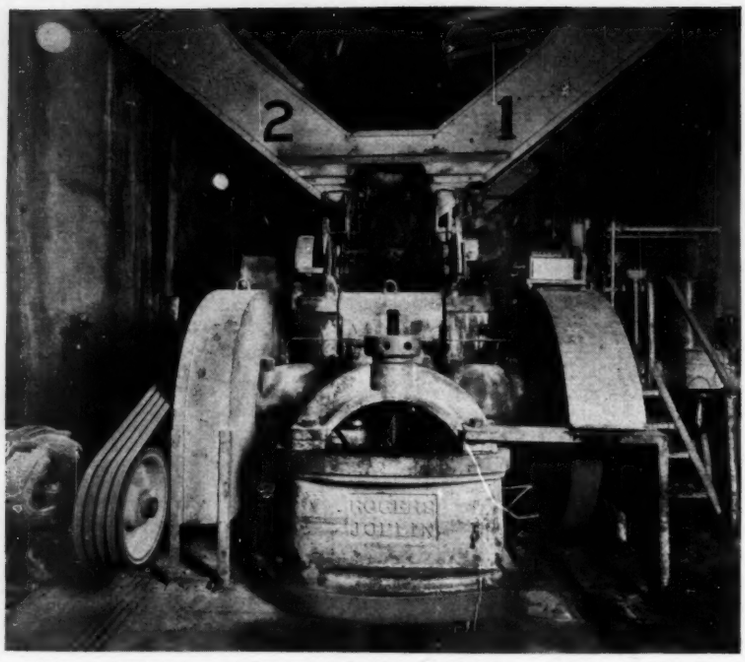


Fig. 4—Primary crusher installation; sampling control mechanism is seen along the wall to the right

nected by a compressed-air line with cylinder No. 1 of the rotatable chute, and when air is admitted at the control mechanism into the line to raise gate No. 1, the chute is rotated to discharge into No. 1 bin. At the same time air is admitted at the top of cylinders Nos. 2, 3, and 4, forcing the gates closed and hence preventing the simultaneous opening of any of these three gates.

The control mechanism consists primarily of four three-way valves, one for each of the four air-lines that operates a hopper-gate cylinder and a complementary cylinder at the chute above the bins at the sampling mill. When one valve is opened the other three valves are automatically locked at the closed position. The mechanism is in the crusher room (see Fig. 4), and a system of automatic light signals enables the operator at the crusher to determine from his position that the various units involved are functioning properly. The entire arrangement has satisfactorily fulfilled the five aforesaid conditions.

Inasmuch as each of the four bins at the sampling mill has a capacity of 50 tons they will individually accommodate the 10 per cent sample cut from 500 tons of ore. This tonnage is about the daily output from each of the three allotments; the fourth hopper and bin provide a reserve for more extensive operations, including the possibility of milling ore from a fourth allotment.

The sampling mill has a capacity of about 35 tons per hour, and therefore it need be operated only about four hours per day, with the main mill operating ten hours and treating 1,100 tons in that period. Ore from each allotment is, of course, sampled separately, the sampling mill operator drawing from one bin at a time. As indicated in Fig. 3, the ore, on being drawn from the bin, travels on a 24-in. U. S. conveyor to a 16-in. Rogers crusher, with a 1-in. opening. The product of the crusher is carried by a 12-in. U. S. conveyor over a tripper pulley, where a 10 per cent cut of the entire stream is taken every 30 seconds by an automatic sampler. This sample is discharged by an 18-in. bucket elevator onto a ½-in. square-mesh Leahy vibrating screen, the oversize passing, in closed circuit, to a set of 18-in. Rogers rolls. The undersize passes through another automatic sampler that takes a 10 per cent cut of the material every 14 seconds. Material rejected by the two samplers falls onto the 12-in. conveyor, which discharges into an 18-in. bucket elevator. From the elevator the rejected material passes to the main conveyor, rejoining the ore stream that is discharged into the mill hopper.

At the second sampler the sample is directed into a 1,000-lb. sample can, which has a hopper bottom equipped with a gate. The can is placed above an M. & S. cone sample grinder, and the contents are fed through the hopper bottom into the grinder for reduction to ⅛ in. Discharge of the grinder is passed through a riffle until the 1,000-lb. sample is reduced to one of 75 lb. This last sample is placed in covered containers and sent to the assay office. One man operates the entire sampling mill, which occupies a 20x27-ft. building. The machinery is arranged in a compact manner and so that the operator can readily see all the moving parts from one position.

The cylindrical, steel mill hopper has a capacity of 800 tons and serves as a surge tank between the subsurface hoppers and the mill. Ore passes from the hopper onto a 42-in. U. S. belt conveyor, equipped with a Dings magnetic head pulley, and then onto a 1-in. square-mesh Niagara vibrating screen. Oversize of the screen comprises the feed to a 7-in. Newhouse crusher, made by the Allis-Chalmers Manufacturing Company and described in detail elsewhere in this issue. The product of the crusher, which has a 1-in. opening, and the undersize of the Niagara screen pass to a 30-in. bucket elevator that discharges the ore in equal portions onto four ⅜-in.-mesh Leahy vibrating screens. Oversize of the screens is fed to two sets of 52x24-in. Rogers spaced rolls, operating in parallel and in closed circuit with the screens. The undersize drops into a 30-in. belt drag, the dewatered product of which is distribuuted equally to four six-cell redwood rougher jigs, with 42x48-in. cells.

Tailing from the rougher jigs passes to a 30-in. belt drag, the dewatered product falling onto a 24-in. tailing conveyor, which consists of a 360-ft., five-ply U. S. Giant belt on Stearns idlers. Wash water to distribute the tailing on the tailing pile is pumped to the discharge of the conveyor by a 8x10-in. Gould triplex pump, driven by a 15-hp. General Electric motor through a Dickrope V-belt, made by the R. & J. Dick Company. The smittem or hutch product from the first two cells and the chats or valuable mineral-gangue grains of the first cell of each rougher jig pass to a 24-in. bucket elevator that discharges into a 24-in. drag, the dewatered product of which comprises the feed for a seven-cell redwood cleaner jig, with 42x48-in. cells.

Smittem and chats from the other cells of the rougher jigs pass to another 24-in. bucket elevator that discharges, in equal portions, onto two ⅛-in.-mesh Leahy vibrating screens. Oversize of

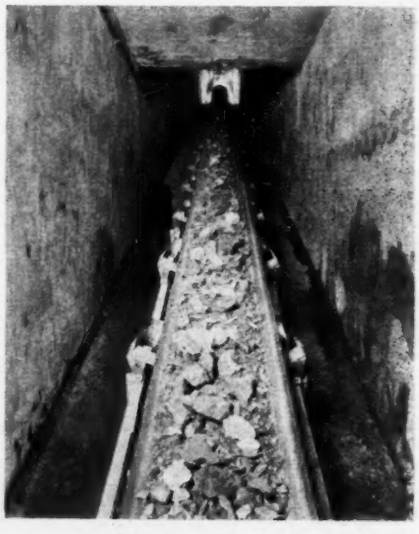


Fig. 5—Looking up the main conveyor gallery

the screens is reduced in a set of 52x24-in. Rogers spaced rolls that operate in closed circuit with the screens. The undersize is dewatered in a 24-in. drag and on leaving the drag comprises the feed to the two five-cell sluffing jigs, with 42x48-in. cells. Tailing from the sluffing jigs joins the tailing from the rougher jigs and passes to the tailing drag. Smittem from the first two cells of the sluffing jigs passes to the elevator ahead of the cleaner jig. The tailing from the cleaner jig is returned to the elevator ahead of the sluffing jigs. Smittem and chats of the other cells of the sluffing jigs, together with the overflow waters from all the aforesaid drags, pass to a large 24-in. sand-dewatering drag. A 24-in. bucket elevator discharges the dewatered product to two 1¼-mm.-mesh Leahy vibrating screens, the undersize of which passes to a 24-in. belt drag. The dewatered product of this drag is distributed equally to six Butchart concentrating tables that make a zinc concentrate and a tailing; a seventh table acts as a cleaner for a lead middling product also obtained from the other six tables.

Oversize of the 1¼-mm. screens passes to a 6-ft. Model D duplex Dorr classifier that operates in closed circuit with a 7x5-ft. Marcy ball mill, directly connected to a 150-hp. Westinghouse slip-ring motor. The overflow from the classifier, together with that from the large sand dewatering drag, flows to a 75-ft. Butchart thickener, equipped with spiral rakes. Two 4-in. Butchart diaphragm pumps force the spigot product of the thickener to two banks of three Butchart flotation machines each, arranged in series. The feed is distributed equally to the two banks of machines, and a lead concentrate is obtained from the first machine of each bank; this flows to a 10-ft. Butchart thickener and thence to two leaves of a six-leaf American filter for final dewatering. The second machine of each bank produces a zinc concentrate that is filtered on the other four leaves of the American filter. A final tailing is produced by the third machine, the froth being returned to the head of the second machine.

Zinc concentrate from the cleaner jig and that from the tables pass to an 18-in. elevator, which discharges to an 18-in. drag. The dewatered concentrate falls into a small hopper, from which it is drawn into a small side-dump, V-bottom car for hand transport to the concentrate storage bins, alongside the mill.

Automatic compressed-air samplers, operated through central remote control, take samples, at ten-minute intervals, of the flotation tailing, table tailing, and the combined rougher-jig and sluffing-jig tailing.

Mill water is supplied by a 12-in., Type L.M. American-Marsh centrifugal pump, with a capacity of 4,500 g.p.m. under a 35-ft. head. The pump is driven by a directly connected 50-hp. G.E. motor. Berry spot-welded split steel pulleys are used throughout the mill, and Dickrope V-belt drives are employed with all the major power units.

The mill structure is of concrete and steel construction throughout. In general design and arrangement of equipment it varies considerably from previous practice in the district. For instance, economical use of space has resulted in the cubical content of this 115-ton-per-hour mill exceeding only slightly that of the average 50-ton-per-hour mill in the district. The main floor, of reinforced concrete, is carried on steel columns and beams, giving rigidity to the building and permitting the space under the floor to be fully utilized. Complete designing of the structure prior to its erection—procedure uncommon in the district—made these features possible, as well as the inclusion in the concrete forms of all conduits and openings for launders, piping, and drains.

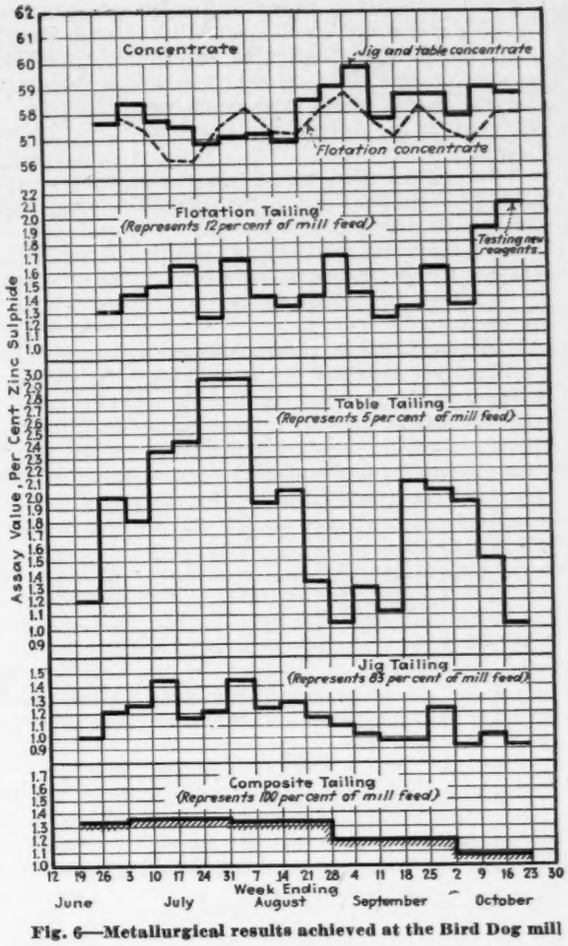

Concentrate
Jig and table concentrate
Flotation concentrate
Flotation Tailing
(Represents 12 per cent of mill feed)
Testing new reagents
Table Tailing
(Represents 5 per cent of mill feed)
Jig Tailing
(Represents 83 per cent of mill feed)
Composite Tailing
(Represents 100 per cent of mill feed)
Assay Value, Per Cent Zinc Sulphide
12 19 26 3 10 17 24 31 7 14 21 28 4 11 18 25 2 9 16 23 30
June
July
August
September
October
Week Ending

Fig. 6—Metallurgical results achieved at the Bird Dog mill

Besides the use of a Newhouse crusher, instead of large rolls, for secondary crushing, the equipment and practice employed in the mill include the following innovations in the district:

1. When ore varies from 18-in. boulders to fines and the breaker product passes directly into the mill circuit, the operator at the breaker cannot deliver a uniform feed to the mill. The steel hopper at the Bird Dog mill acts as a surge tank, and the 42-in. belt conveyor, operated by a constant-speed motor directly connected through a speed reducer and chain to the shaft of the head conveyor pulley, delivers a uniform quantity of minus 4-in. ore from the hopper for any setting of the discharge gate.

2. All elevators are equipped with Timken pit pulleys of special design and with malleable iron cups. The use of common elevator bearings, with packing glands, is impracticable, because bearing wear allows grit to enter that soon destroys the bearing. An anti-friction bearing was designed and installed two years ago at one of the other mills of the company. This bearing has been satisfactory in every respect, and consequently similar bearings were installed at the Bird Dog mill.

Elevators are of concrete construction to the floor line and designed so that ample working room is provided near the pit pulley. Above the floor line a ¼-in. welded-steel housing is employed, the width of which is just sufficient to admit the elevator belt. This arrangement conserves space on the upper floor.

The use of malleable iron cups in the Tri-State district is a radical departure from common practice. These cups on the dirt (ore) elevator, according to all indications, will handle a total of about 250,000 tons, whereas steel cups used for the same purpose in other mills of the company have handled but 66,000 tons. The malleable iron cup costs 60 per cent more than the steel cup but wears three to four times as long.

3. In constructing jigs in the district, 1x12-in. pitch boards are inserted after the body of the jig has been completed. When the finished jig has been in operation a short time, the space beneath the boards becomes filled with zinc and lead concentrates that add, in a six-cell jig, about 40 tons to the weight of the jig. At the Bird Dog mill, the pitch boards, of 2x6-in. redwood, were built in as the construction of the individual jigs progressed. The space under the pitch boards was consequently kept open, and the necessity of supporting an additional dead load of 40 tons per jig avoided. Moreover, this is the first

mill in the district in which all the jigs are of uniform cell size.

All the jigs are supported directly by the concrete floor, rather than by concrete piers, which are commonly employed in the district for jig foundations.

4. Design of the tailing conveyor includes a trough under the carrier idlers that provides a sluiceway for spillage from the belt. This feature removes the possibility of severe wear of the idlers by tailing piling up under them.

5. Rogers 52x24-in. spaced rolls, with ⅛-in. opening, are employed in grinding chats.

6. Numerous attempts have been made to discard a finished tailing from what are known in the district as sand jigs. I endeavored to do this at another mill of the company, but was only partly successful. Enough data were obtained, however, to convince me that such a circuit was possible if the jigs were designed properly. Furthermore, if such a circuit could be successfully applied, it would decrease the load to the table, ball mill, and flotation sections; provide definite control of these sections; and permit less restricted operation of the roughing jigs at the head of the mill.

The circuit has been applied with exceptional success at the Bird Dog mill, and the metallurgical efficiency resulting has been particularly gratifying. From 83 to 85 per cent of the gangue entering the mill is discarded by the rougher and chat jigs, the average tailing assay value since the beginning of operations to Oct. 31, 1930, being 1.18 per cent zinc sulphide. For the month of October, 1930, the tailing assay value averaged 0.97 per cent, and an average value as low as 0.62 per cent has been obtained for a single shift. The mill feed ranges, in assay value, from about 7 to 10 per cent zinc sulphide.

7. The dewatered product of the large sand drag, which receives overflow waters and smittem and chats from the sluffing jigs, passes to a sand elevator and thence to two 1¼-mm.-mesh screens. After desliming, the undersize of the screens comprises the feed to the table section of the mill.

A decision to use this circuit was based on tests made at another mill of the company. These tests showed that (1) tables will not separate a chatty product; (2) tables are most efficient when the feed is minus 1¼ mm. and plus 65 mesh; (3) a classified feed complicates the table circuit and does not result in a lower composite tailing than does a distributed feed; (4) a variation of feed sizes on a table increases its efficiency.

Consequently a decision was made, first, to prepare the feed properly, and then to distribute it to the tables. Results have upheld the tests, the average table tailing assay value for October, 1930, being 1.32 per cent zinc sulphide.

In the ball-mill circuit the oversize of the 1¼-mm.-mesh screens passes directly to the ball mill, where it is reduced to flotation size. This procedure is employed because practically all the plus 1¼-mm. feed consists of chats, from which the valuable minerals can be freed only by grinding. Owing to the excellent operation of the sluffing-jig circuit, the ball-mill circuit is operated at only about 45 per cent capacity. This effects a material operating economy.

8. Lubrication of the entire mill was placed in charge of J. C. Dittbrenner, a representative of the Vacuum Oil Company, whose recommendations were followed explicitly. As a result, the mill is being referred to as an example of lubricating efficiency.

A tabulation of the items comprising the total milling costs, including surface ore haulage, for the months of August and September, 1930, follows:

Labor	$4,536.01
Supplies and repairs	6,868.36
Liability insurance	161.95
Fire and tornado insurance	83.32
Electricity	5,080.44
Water, ice, and fuel	12.00
Fee to producers' association	346.60
Depreciation (10c. per ton)	5,300.91
Total	$22,389.59

In this two-month period, 53,008 dry tons of ore were milled in 493 hours at an average cost of $0.42238 per ton and at an average rate of 110.2 tons of ore per hour. The capacity of the Bird Dog mill was not reached during the aforesaid period. Recent tests show that 41.5 per cent more ore per man-shift than the average treated at the other mills of the company is handled at the Bird Dog mill.

Composite tailing assay values, in zinc sulphide, by months, since the mill was placed in operation follow: June, 1930, 1.34 per cent; July, 1.37 per cent; Aug., 1.34 per cent; Sept., 1.18 per cent; Oct., 1.09 per cent. Additional metallurgical data are presented in Fig. 6.

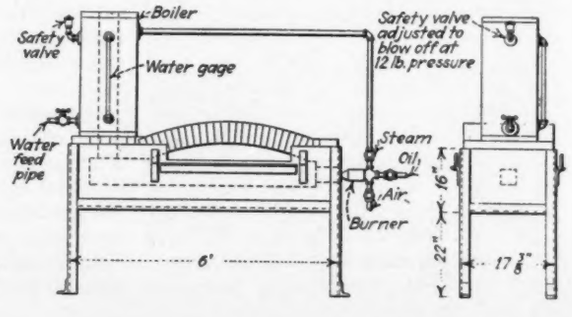
In conclusion I wish to express my gratefulness to the owners of the Commerce Mining & Royalty Company, who, through their financial resources and faith, made possible the completion of this pioneer project. To them I am also indebted for permission to publish the foregoing account.

■ ■ ■

Low-Pressure Steam Improves Drill Furnace Operation

IN ADDITION to a superior grade of sharpened drill steel, economies in oil and air have resulted by the development and installation of new oil-fired rock-drill furnaces at the central drill-sharpening shop of the Copper Queen Branch of Phelps Dodge Corporation, at Bisbee, Ariz. The novel feature of the furnace, shown in the accompanying drawing, is the use of steam in place of air for combustion. Injection of steam at 12-lb. pressure results in a moist flame, which in turn effects a slightly reducing atmosphere within the fire chamber of the furnace, and thus prevents decarbonizing and scaling of the steel during the heating process. Air, however, is used for starting the furnace and to generate the necessary amount of steam. The furnace proper, consisting of a shell made of 2½-in. angle iron and ⅛-in. plate, and lined with standard firebrick, is so designed that the steel can be inserted from both back and front, thus supplying hot drills to two sharpening machines with but a single fire.

Steam is generated in a small boiler placed above the discharge chamber of the furnace, utilizing the available waste heat. With the installation of a safety valve, adjusted to blow off at 12-lb. pressure, and a small water gage to indicate to the operator the exact water level within the boiler, continuous operation, plus safety, are assured. The oil, air, and steam on the burner, as well as the feed water, are controlled by small valves on the corresponding pipe lines.



Method of using steam in rock-drill furnace

Electrothermic Zinc

A Review by G. Newton Kirsebom

THE closing of the last electrothermic zinc plant in Sweden brings the era of electrothermic zinc reduction, introduced in the Scandinavian countries about twenty years ago, to a close. Whether the abandonment is final or not is hard to predict. Steady improvements made in the electrolytic process, and the introduction of the continuous retort, make competition impossible even in countries where electric power is exceptionally cheap, unless radical improvements and simplifications are made. Much significance may be attributed to the fact that in Norway, where perhaps most money and effort have been expended on the electrothermic process, an electrolytic plant of American dimensions has recently been built under the direction of American experts.

Twenty years ago, when electrolytic zinc was still in its infancy, and when the retort plants were struggling with the problem of excessive labor, electric smelting of zinc ore in a closed furnace seemed attractive. It provided means for continuous feeding of large units, the use of slag-forming fluxes, and recovery of byproducts such as lead, copper, and precious metals. Developments, almost all confined to the Scandinavian countries, were followed with keen interest by metallurgists all over the world, and large sums were invested in these enterprises, investments that have given meager returns.

From de Laval's little two-phase furnace to the modern large three-phase units is undoubtedly a great step in the line of progress. That further improvements in the metallurgical branch of the process have not been possible with the modern electrical equipment for regulation of the current now available is regrettable.

In the initial stages of the process the fact was soon discovered that zinc could not be condensed and recovered directly in marketable form, but collected in the condenser as a medium-grade zinc dust. Efforts were made, especially in Norway, to solve this difficulty, but with little success. The Cornelius procedure, by which the dust was removed from the condenser and treated in an electric revolving furnace, put the process on a practical basis, and it has been operated thus ever since. This is really the most interesting metallurgical development made in the process. The zinc dust is fed continuously to a revolving furnace, and the major portion is recovered in marketable form at small expense. A small amount of dross, consisting mainly of finely divided zinc oxide, is discharged automatically by the rotation of the furnace. Such a process should be of interest to the retort plants for treatment of blue powder, but it has not yet found application. The only installation of similar nature I have seen was in an electrolytic zinc plant, where dross from the cathode melting furnace was treated thus to avoid the use of ammonium chloride.

A high extraction of zinc as high-grade zinc dust in the primary furnace is of great importance for the economy of the process. The recovery in the revolving furnace is largely dependent on the grade of the zinc dust produced, and the dross from this furnace must be included in the charge to the primary furnace, where it is an undesirable constituent, mainly on account of its extreme fineness. Production of a high-grade zinc dust seems to be prevented by the conditions of the furnace itself. Arcing produces such extreme heat that many undesirable elements are carried into the dust, and the possibility of overcoming this condition is remote.

Another factor of great importance is the character of the slag. Prior to differential flotation, the treatment of zinc-bearing ores in a lead furnace constituted a great problem. The discovery was, however, soon made that an excess of iron in the charge would flux the zinc. Whenever the charge was high in zinc a corresponding amount of iron was therefore added. In the electrothermic zinc furnace the exact opposite is desired. Presence of iron in the ore, which tends to retain a corresponding amount of zinc, is a distinct disadvantage, as it also is in electrolytic zinc practice, where the formation of insoluble zinc ferrite reduces the leach recovery. The solubility of zinc oxide in ferrous silicate is a function of the temperature. As absolute control of furnace temperature is not possible, a slag with a constant zinc content cannot be maintained. By using an acid flux, the solubility of the zinc is materially decreased. For many years an acid slag was therefore used. In fact, the slag was sometimes so acid that it would run out of the furnace as a viscous mass, containing inclusions of ore and flux. This was later remedied by adding sufficient lime with the silica to give a fairly basic calcium silicate. At the temperature used this easy flowing slag tended to reduce the major part of the iron to the metallic state, allowing it to go to the matte rather than to the slag.

THE author, recently engaged in work on electrothermal zinc at Trollbättan, Sweden, is associated with the inventor of the Harris process for refining lead, and with Dr. Edward Heberlein, with whom he has developed a new process for the reduction of cadmium, in connection with which he is now conducting large-scale experiments in the United States.

Thus a slag of low zinc content and fairly uniform consistency was produced, making metallurgical calculations easier and paving the way for a better understanding of the reactions in the furnace. The disadvantage of this procedure was the large amount of flux needed and the resulting heavy slag fall, making frequent tappings necessary.

At the high temperature of the furnace lead is recovered with the zinc dust, and cadmium also distils over. In addition to these impurities, the raw zinc also contains some iron and copper. Refining of this raw zinc is done in a large electric-arc furnace, where a cadmium-bearing zinc and a pig lead fairly free from zinc are obtained. Copper and iron gradually accumulate as a half-molten iron-copper-zinc alloy floating on the lead. This is occasionally removed, broken up, and charged back to the primary furnace.

The fact that cadmium is not recovered is a serious drawback to the process, considering the present high price of this metal and the demand for a zinc of high purity. In the old retort process a certain degree of cadmium control may be effected by regulation of the prolongs.

Complex lead-zinc-copper ores were treated profitably by the electrothermic process prior to the introduction of selective flotation. The zinc in the ore, then of almost no value, was recovered in the refining furnace; copper, lead, and precious metals were recovered in the matte. With the improved methods of flotation, the value of the zinc in these ores has increased sufficiently to offset this advantage. Lately, the stricter demands for a zinc of high purity have limited the market for electrothermic zinc—high in cadmium and of fairly high lead content—to consumers to whom these impurities are not objectionable.

Geology and Mining Laws of Newfoundland

Pilley's Island, in Notre Dame Bay, showing main shaft

Frederick W. Foote

Foote & Eaton
Consulting Engineer, New York, U. S. A.

NEWFOUNDLAND comprises the most easterly land of North America. It is roughly triangular in shape, about 330 miles on a side, but owing to the numerous indentations has a 4,000-mile coast line instead of 1,000. As will be deduced from a study of the map, its main features are governed by a northeast-southwest habit, the lakes, mountains, and bays having this general axis. This is caused by a series of folds whose axes are northeast-southwest. These pitch slightly northeast and dip southwest. Thus the western coast ascends rapidly to a range of mountains of which several peaks reach over 2,000 ft. in altitude. These are known as the Long Range Mountains. These mountains, together with some of the fjords that cut them, give the same impression as the coast of Norway or northern British Columbia and southeastern Alaska. As one progresses southeastward the altitude becomes lower and the bays longer and deeper, apparently owing to greater submergence. A neck of land but a few miles wide separates the heads of Placentia Bay and Trinity Bay and saves the Avalon peninsula from being a separate island.

Vegetation is more abundant along the western coast, and by the time St. Johns is reached the country is quite barren. St. Johns, on the extreme eastern coast, enjoys a well-protected harbor, but its adjacent coast is exposed to the full vagaries of the North Atlantic. It is fortunate that the sinking did not progress a few hundred feet further, which would have removed Bell Island and its iron outcrop—thus appreciably changing the mineral history of the island. This is illustrative of the narrow margins occurring in nature.

Work of the Newfoundland geological survey was resumed in the last few years by H. A. Baker as government geologist. For several years Hans Lundberg, of the Swedish American Prospecting Company, has been carrying on aggressive geological research in the central part of the island; the most interesting from a mining viewpoint. I am indebted to Mr. Lundberg for the following generalized notes:

Newfoundland, so far as known, is composed entirely of Pre-Cambrian and Paleozoic rocks. Although the government map shows Pre-Cambrian rocks to predominate, further work will probably resolve much of the territory now classified as "Laurentian and Undetermined" into the Paleozoic, and possibly later formations.

Of the known Pre-Cambrian, the following divisions have been identified: (a) Laurentian; (b) Huronian; and (c) Avalonian.

(a) Laurentian: This classification has been applied rather loosely to gneisses and other crystalline rocks which underlie the oldest fossiliferous formations. Ancient rocks of this class are exposed in the Long Range Mountains on the west coast, and are also found in parts of the interior. The core of the Avalon peninsula is said to be of the same formation.

(b) Huronian, possibly together with some Animikie and Keweenawan detritals, occurs on the southeast coast, where also are found a series of non-fossiliferous sediments known as (c) Avalonian, and resembling somewhat the gold measures of Nova Scotia.

In structural depressions and as fringes upon the Pre-Cambrian are found Paleozoic sediments and lavas. Probably of Paleozoic age also are widespread igneous intrusions in many places as yet undistinguished from the Pre-Cambrian igneous rocks.

Cambrian sediments surround the flanks of the Long Range Mountains and are also found in small patches on the east coast. Probably also of this age are pillow lavas and pyroclastics in Notre Dame Bay, on the northeast coast.

On the Avalon peninsula, Ordovician sandstone and shale contain the extensive sedimentary hematites of Wabana. In Notre Dame Bay and the Exploits this was an age of intermittent but widespread vulcanism, accompanied by shallow and deep-water sedimentation. On the west coast, Lower and Middle Ordovician limestones are well developed. Rocks of Silurian age are widespread. None are known on the east coast, but on the northeast coast and as a fringe along the west coast Lower and Middle Silurian sediments are found, possibly with minor amounts of volcanics. It may be noted here that much of the areas mapped officially as Silurian are in reality Ordovician.

Devonian rocks are rare, there being but a restricted development in the White Bay trough on the northeast coast. The latest sedimentary record is Carboniferous. Late Lower Carboniferous detritals, dolomite, and gypsum are found on the west coast, overlain by the coal measures. This is an extension of the Carboniferous basin of Nova Scotia.

Structurally, the most conspicuous feature of the island is parallel folding along axes striking about N. 30 deg. E. (true), and involving both Pre-Cambrian and the Paleozoic rocks. In a general way, the long peninsulas correspond to anticlines and the bays to synclines.

The periods of deformation are referred to Late Devonian, the Ordovician, and Late Carboniferous. Elevation with east-west tilting occurred in the Late Cretaceous, followed in the Tertiary by further elevation and by resilient uplift on the north coasts after the melting of the Pleistocene ice sheets.

Transportation is an all-important factor in the development of a country. In Newfoundland today it is mainly by water. The "outports"—that fringe of villages and hamlets dotting the entire periphery of the island—are connected to St. Johns and hence the outside world by a weekly steamship service operated by the government. The government railroad crosses the island

from St. Johns to Port-au-Basques, on the west coast, with branches to coast at strategic points. A branch line runs to Buchans mine and a motor road runs to Halls Bay—the point of departure to Notre Dame Bay points. This is a narrow-gage system that in the past has been the subject of much humor in Canada and the United States. Recently, however, the roadbed has been improved and heavier rails have been installed, so that the service compares favorably with that on the mainland. The road compares favorably with the Cuban railways and others of similar density of traffic.

Off the beaten tracks, gas boats are used along the coast and canoes along the multiplicity of inland water systems. The river and lake systems are so extensive that, with a little planning, one can go anywhere without excessive portaging.

The island is bountifully supplied with hydro-electric power — developed and potential. A rather careful reconnaissance of the water-power possibilities was made in 1923 to submit in connection with the Wembley exhibit in London in 1924.

Both location and size of these powers are shown by the map on this page.

The outstanding power developments are in connection with the paper operations at Grand Lake and Grand Fall. The Gander River scheme is the largest undeveloped power.

Mining laws of Newfoundland are those passed in 1921 with certain amendments made in 1928. They are normal and place no restrictive effects on mining. Briefly they are as follows:

1. Any person or company may obtain a miner's license upon payment of $5.

2. Upon making a discovery on crown lands, a discovery stake must be placed. This entitles the discoverer to a license to the discovery for one year.

3. Within two months, description and map of the discovery, referencing it to known topographic features, must be filed, together with $10. A claim ½ mile on a side (160 acres) is laid out, the strike of the discovery being parallel to one side.

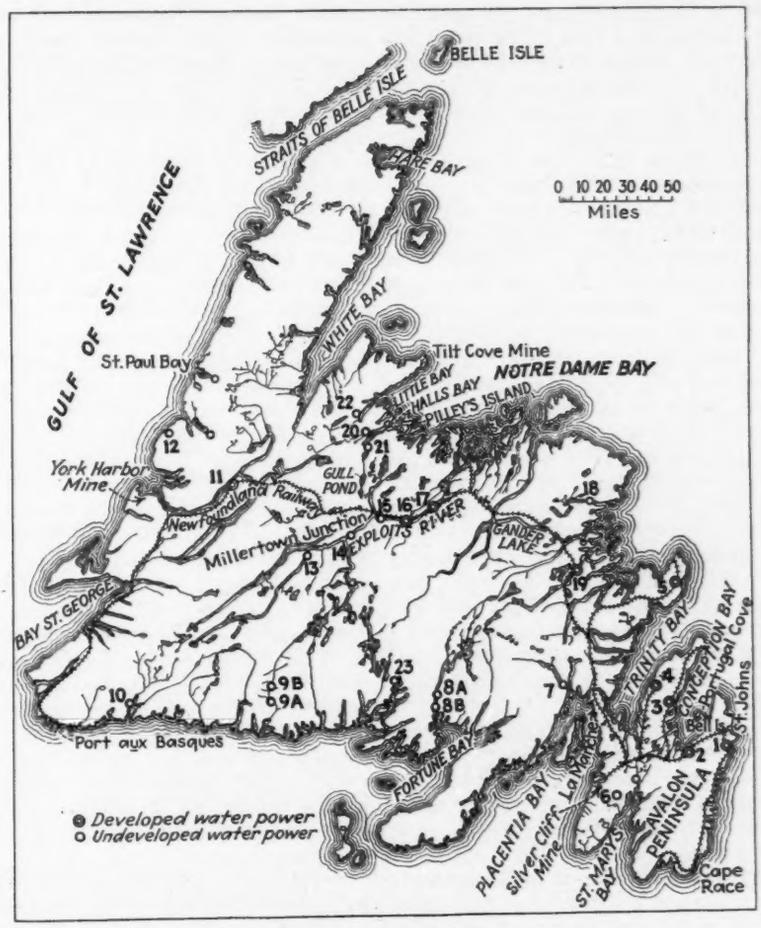
4. The license can be transferred into a fee-simple grant upon proof of the expenditure of $6,000 in the first five years for mining not less than 10,000 cu.ft. of earth or rock on a license of 160 acres; or, as an alternative, $6,000 in diamond drilling at $5 per foot, or $6,000 worth of geophysical prospecting, or $6,000 aggregate from all three.

The laws for the regulation of mining operations are equable and require but normal procedure for the protection of life and the minimizing of accident risks.

A further revision was passed in the House to become effective in November, 1930, conforming more closely to the Ontario laws. The main item of difference is the changing of the mining claim to 40 acres in area, and the inclusion of geophysical prospecting as one of the alternatives for fee-simple grant.

The average Newfoundlander is used to hard work under trying conditions. His versatility is marked. Many of the citizens of the island have mined at one time and another. Wage scales at Buchans and Wabana are at present 30 to 35c. per hour for unskilled labor and 50c. for skilled labor. Conditions corollary to mining operations are not unfavorable. Newfoundland is strategically situated with respect to the raw material market in Canada, the United States and Europe. Output can for the most part be borne by water to markets. Power, timber, and labor are available, and the government's attitude toward mineral development is favorable. Under these conditions, I have been interested in making a study of the past and present of the mining industry, and hazard a guess in regard to its future.

The study of past operations will be limited to a summary of properties operated in the past and now idle. The first was at the Tilt Cove mine, on Notre Dame Bay (see map). It was discovered in 1857, and operations were started in 1864, the property being



Map of Newfoundland

No.	Brook	Locality	Head, Ft.	Hp. Developed	Hp. Estimated
1	Petty Harbor	Near St. John's	192	3,600	....
2	Seal Cove	Conception Bay	....	1,800	....
3	Carbonear	Conception Bay	210-300	500	1,500
4	Hearts Content	Trinity Bay	165	2,000	3,000
5	Catalina	Trinity Bay	50	800	....
6	Rocky River	St. Mary's Bay	60	....	1,500
7	Pipers Hole	Placentia Bay	140-150	....	10,000-12,000
8	Bay Du Nord	Fortune Bay	A-65, B-90	....	8,000
9	Grey River (Little R.)	South Coast	A-72, B-143	....	20,000
10	Broad Cove Br.	La Poile Bay	400-500	....	1,500
11	Grand Lake development, Humber River	Deer Lake	235	100,000	200,000
12	Trout River	North of Bay of Islands	40-60	....	1,000-2,000
13	Victoria River	Exploits River Basin	46	....	5,800
14	Red Indian Falls	Exploits River Basin	46	....	9,800
15	Badger Chute	Exploits River Basin	33	....	8,200
16	Grand Falls	Exploits River Basin	110	23,500	50,000
17	Bishops Falls	Exploits River Basin	33	11,000	13,000
18	Gander River Scheme	Indian Bay	140-150	....	Probably Exceeds 100,000 hp.
19	Terra Nova River	Grants Falls	60	5,660	....
20	Indian Brook	Halls Bay	....	....	....
21	South Brook	Halls Bay	30-40	....	1,500-2,000
22	Rattling Brook	S. W. Arm, Green Bay	595	....	2,000
23	Bay D'Est	South Coast	523	....	160,000

known as the Union mine, and latterly the West mine. The ore is a chalcopyrite with accessory pyrite occurring in a massive olivine basalt. The footwall is a massive diorite dike. At the West mine the chalcopyrite occurred in masses, veinlets and minute disseminations in this basalt over widths of 200 ft. or more and for a length of over 800 ft. During the next twenty years this orebody was opened up for a vertical range of 400 ft. up the hill from the cove level and a shaft was sunk 240 ft. and the orebody explored to this depth. The work was done entirely by hand methods and the governing factor was the ferreting out of bunches of ore that could be hand-picked to run over 12 per cent copper. This of necessity left behind all stringers and disseminated material. During this period a total of 65,000 tons of 12 per cent hand-picked ore was shipped.

In 1886, the East mine orebody was discovered and in 1888 the property was leased to a London company. The new orebody was found to be an irregular-shaped mass of pyrite containing about 4 per cent copper. Furnaces were built for pyritic smelting. This process at this time was imperfectly developed, and the London interests became heavily involved and subleased the property to the Cape Copper Company, which shipped the ore to Swansea for smelting and also sent some to New York, where the sulphur was roasted for acid manufacture and the copper recovered in a matte. During the period 1888 to 1910, the property was operated continuously and over 1,000,000 tons of 4 per cent copper and about 35 to 40 per cent sulphur was shipped. This was the heyday period of the old Tilt Cove operation—profits amounting to about $5 per ton of ore.

In 1894, the West mine shaft was sunk to 480 ft. (80 fathoms) and some development done, still seeking the bunches of high-grade ore. Some high-grade ore was obtained in the next eight years.

In 1907 some pillar-and-roof supports were taken out and the Elmore flotation process, then being developed, was considered, but the patent litigations deterred the directors from adopting the process for the large tonnages of ore containing the veinlets and disseminated copper. Development in the East mine was not maintained and production dwindled. Finally, the Cape Copper Company relinquished its lease and the property reverted to Newfoundlanders, prominent among whom were the late R. G. Rendell and J. M. Jackman. Still apprehensive of the status of flotation litigation they purchased an electrostatic plant for the recovery of the ore in the veinlets and the disseminated copper. This did not give the desired results and marked the cessation of mining at Tilt Cove. Based upon a several years' study of the property and its ore from all standpoints, I venture the statement that had any of the flotation processes been installed, Tilt Cove would be operating today and contributing an appreciable tonnage of copper to world production. The history of Tilt Cove to date is illustrative of the importance of management and the necessity of maintaining development and keeping in touch with current metallurgical progress. As a result of the operations there, active prospecting along the shores of Notre Dame Bay was carried on and resulted in the discovery of the Betty Cove mine, about 10 miles west, in 1874. The occurrence in general consisted of pyrite and chalcopyrite occurring in a pillow lava. This ore, however, had an appreciable gold content and some sphalerite. From 1875 to 1884 a total of 125,000 tons of 10 per cent copper was mined and shipped. An overhanging bluff caved in 1885, wrecking the mine, then developed to 400 ft., and operations were abandoned.

This prospecting campaign also disclosed in 1878 an outcrop at Little Bay—still further west of Notre Dame Bay. The ore was of the same general occurrence as that at Tilt Cove West mine—namely, chalcopyrite and pyrite as masses, stringers, and disseminations in the olivine basalt. Operations started soon thereafter. A smelter was built and some smelting done. The production in the next 25 years is said to have amounted to 300,000 tons of 10 per cent ore—from hand picking the bunches and masses. The stringers and disseminations were left behind. The mine reached a depth of over 1,400 ft. and the orebody was mined over an average length of 600 ft. Water was removed by Cornish pumps and all drilling was done by hand. When this depth was reached water and hoisting became serious problems, which, combined with the then existing low prices of copper, caused final abandonment. Incidental to this mining, about 300,000 tons of 2 per cent material was hoisted and placed on dumps.

Several other properties in this region were discovered and some development was done, but none reached any appreciable production. All disclosed ore of the same general character and occurrence. The aggregate production of these properties during the 80's caused Newfoundland to rank as the sixth among copper-producing countries of the world.

Another area of interest historically is the Argentia-La Manche district, not because of the size of its output but for the metal contained in the ores. The La Manche lead mine, on the neck of land connecting the Avalon peninsula with the main portion of the island, was discovered about 1855 and was later acquired by Cyrus Field and his associates, who were then engaged in laying the first Atlantic cable, the landing of which was in Placentia Bay, near the outcrop. The vein is a steeply dipping fissure vein of galena in calcite gangue occurring in slates. The vein has an average thickness of 4 ft. and is traceable from the shores of Placentia Bay inland for several thousand feet, and it has been traced under the bay over a thousand feet further. Former operations consisted in the sinking of several shafts to water level (150 to 200 ft.) and the mining and hand-picking of the bunches of galena. Total production amounted to 2,375 gross tons of galena running about 60 per cent lead. The property was closed down in 1873, lead then being about 3c. per pound. The ore averaged about 10 per cent lead. Disseminated material was not treated, so that the output comprised the bunches only. The galena is silver-free.

At Broad Cove, opposite Argentia, a series of veins of sphalerite and galena was discovered about 1880, and prospecting in the general locality indicated a number of veins of this type. About 1925, the Silver Cliff Mining Company was formed with St. Johns capital, and the Silver Cliff mine was equipped with a compressor and a 50-ton concentrator containing jigs and tables. The ore is a mixture of galena (silver-bearing) of which about an 80 per cent recovery was made. The sphalerite was wasted, as was the pyrite content. A sample of this pyrite analyzed over $6 in gold per ton. Development work was kept insufficiently far ahead of mining, which combined with the small tonnage handled and incomplete recovery of the valuable metals, resulted in failure to make profits, and the operation was therefore discontinued after a period of brief duration.

Pyrite was discovered about 1875 on Pilley's Island, in Notre Dame Bay, as a result of the prospecting for copper properties. The ore was found in massive form in parallel lenses of considerable thickness, one being copper-bearing and the other barren of copper. The property was operated more or less continuously from 1890 until 1908, during which time about 425,000 tons of ore was shipped—mostly to New York for acid manufacture. By this time the dip of the lenses had taken them to a fault plane, and the operators were unsuccessful in finding the extensions beyond the fault by underground development. Later diamond drilling, after the property had passed to the August Heckscher interests, was successful in finding the continuation of the lenses, and considerable additional ore was developed. This was in 1919. In the interim, the plant had been dismantled and sold, and to date the property has not been re-equipped.

Except for some other minor activitives that resulted in neither appreciable production nor profit, this completes the summary of past operations. It is to be noted that practically all of these suspended not through exhaustion of orebodies but through poor control or management and insufficient development.

SHAFT HORSEPOWER CHART

Designed and Copyrighted by

Sydney C. Mifflen

Glace Bay, Nova Scotia, Canada

WITH the aid of this chart may be found the horsepower a shaft of given diameter will safely transmit, when the shaft is making a given number of revolutions per minute and in use in a definite class of service, as mentioned below or vice versa.

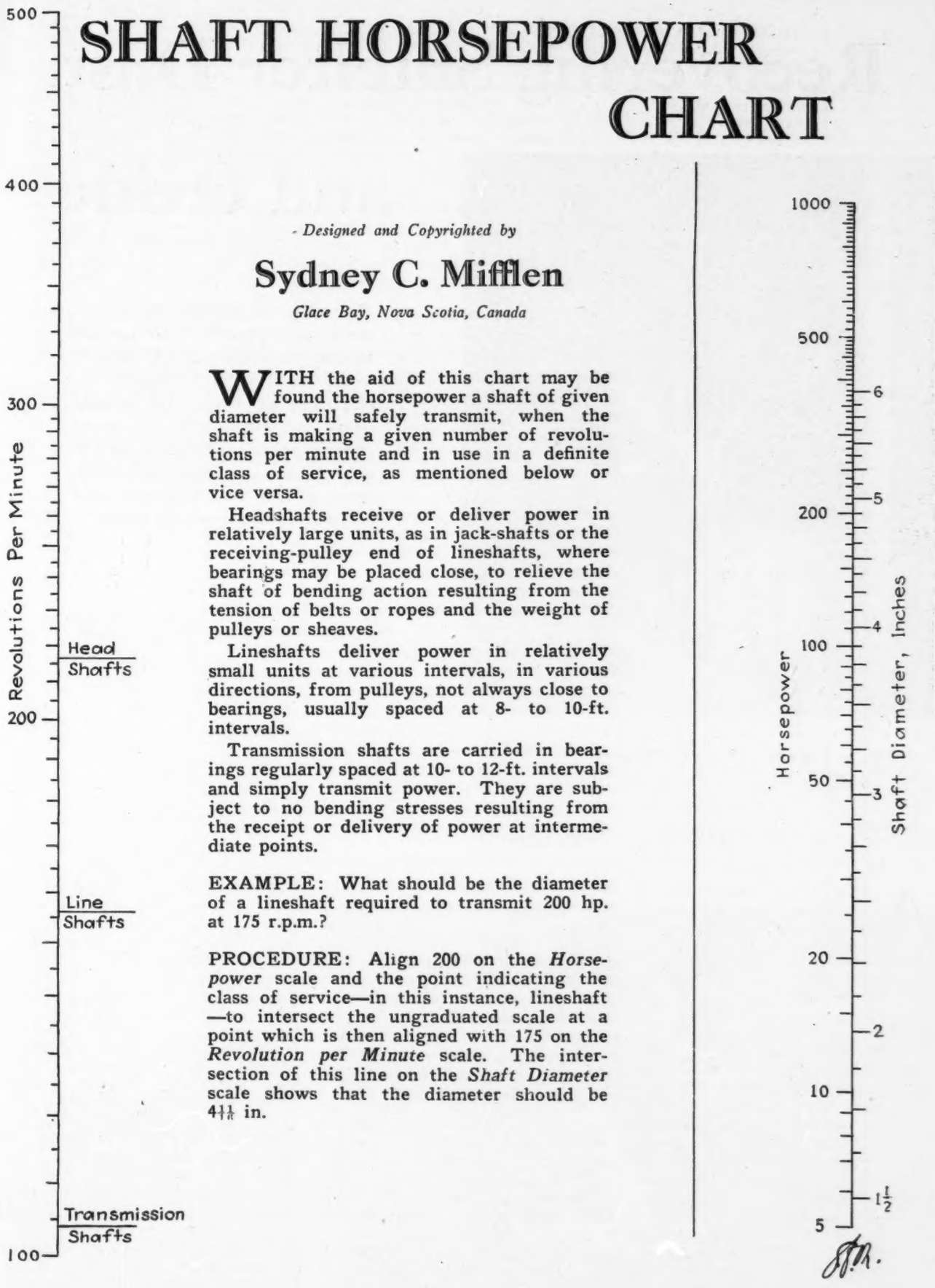
Headshafts receive or deliver power in relatively large units, as in jack-shafts or the receiving-pulley end of lineshafts, where bearings may be placed close, to relieve the shaft of bending action resulting from the tension of belts or ropes and the weight of pulleys or sheaves.

Lineshafts deliver power in relatively small units at various intervals, in various directions, from pulleys, not always close to bearings, usually spaced at 8- to 10-ft. intervals.

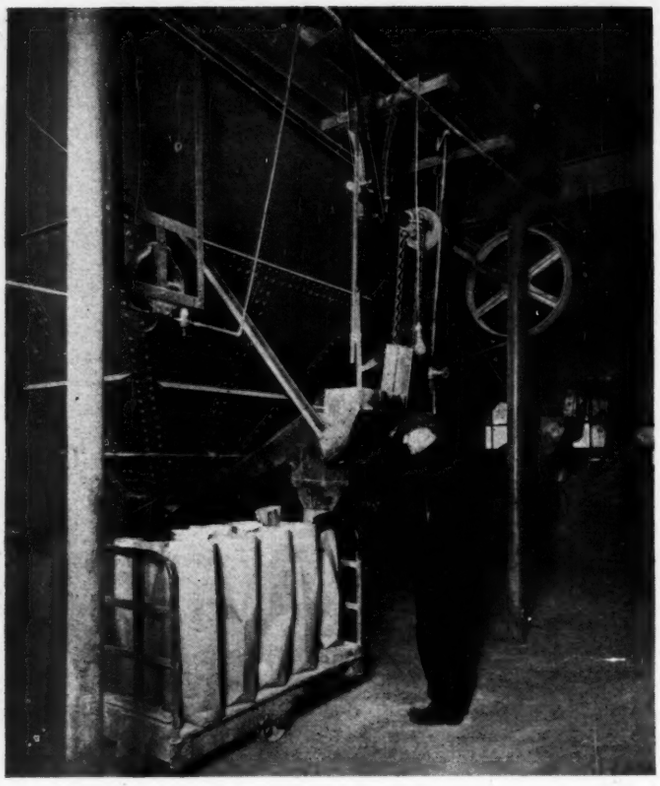
Transmission shafts are carried in bearings regularly spaced at 10- to 12-ft. intervals and simply transmit power. They are subject to no bending stresses resulting from the receipt or delivery of power at intermediate points.

EXAMPLE: What should be the diameter of a lineshaft required to transmit 200 hp. at 175 r.p.m.?

PROCEDURE: Align 200 on the *Horsepower* scale and the point indicating the class of service—in this instance, lineshaft —to intersect the ungraduated scale at a point which is then aligned with 175 on the *Revolution per Minute* scale. The intersection of this line on the *Shaft Diameter* scale shows that the diameter should be $4\frac{11}{16}$ in.



Recovering Smelter Dust and Oxide



Description of practice and equipment and technical control, in the modern secondary-metal smelter of a leading metal manufacturing and refining firm, that should prove interesting and helpful to those engaged in this phase and in other phases of mining and metallurgical work in which dust and fume recovery is a problem

N. F. Kepner, *Works Manager*
W. Romanoff, *Technical Superintendent*
C. O. Thieme, *Metallurgical Engineer*

H. Kramer & Company, Chicago

AN INDUSTRY based upon salvaging, smelting, and refining non-ferrous secondary metals and residues has grown to tremendous economic importance within the last 25 years. New or improved processes, by which losses are reduced, have played an important part in establishing the economic position of the industry. In line with this program and in order to recover the metal lost by mechanical dusting, volatilization, and oxidation, smelters of secondary metals are undertaking collection of fume and dust. Smelters in metropolitan areas find it necessary to consider collection of dust apart from economic reasons, because of its being a neighborhood nuisance.

Those familiar with brass smelting are aware of the metal lost throughout the smelting and refining process and, to a lesser degree, during the casting period. This loss consists largely of zinc, with smaller percentages of lead, tin, and copper in the order named. The tremendous quantity of dust and oxide particles liberated into the air in such work has been the subject of attention for the last five years or more by the health and smoke control departments of the Chicago city government. They recognize not only a health hazard here but a great economic loss by the inhabitants of metropolitan areas incident to deterioration of household furnishings and to cost of frequent redecoration. The activity of the city departments mentioned caused us to search for a remedy for our particular problem. The actual loss to a smelter is very appreciable, for we found by close calculation that 2,500 lb. of zinc and other metals was lost daily from each furnace in operation. Through the two main stacks shown in Fig. 2 an oxide loss of 3 to 4 tons per day occurred.

Several types of dust-collecting systems were considered and finally the Dust Recovering & Conveying Company, of Cleveland, Ohio, was awarded the contract for the installation herein described. Before describing this equipment and its operation, the preparation of scrap for the smelting furnaces, and the furnace operation, will be summarized.

The treatment of brass scrap is dependent upon its physical nature, as the particles vary from a small fraction of an ounce to pieces weighing several tons. Fine material such as borings is dumped on the floor, mixed by coning, and sampled by quartering as it is placed in a bin. Larger material, such as castings of various types, varying in weight from an ounce to 40 or 50 lb., is hand-sorted to pick out undesirable metals and foreign material. The smaller castings are put over an endless-belt magnetic separator to remove free iron. Iron present in larger pieces is cut out with a power shear. Tubing, molding, strips, and material of odd shape are cut to convenient charging size or briquetted. Copper wire is hand-sorted and briquetted. Heavy wire and flat copper are cut into convenient size for crucible and furnace melting. Light brass, electrical sheet brass, and similar material is hand-sorted, magneted, and briquetted. Almost all light-gage clippings, sheets, and other material of like nature are briquetted to reduce handling cost and metal loss. Samples varying in size from 100 grams to a ton are melted and analyzed to determine the metallic yield and the composition of metal. It is necessary to check material constantly to determine the proper means of disposal and to form a basis upon which to fix value. Brass skimmings which are of very unequal particle size require careful separation, crushing, and screening to sample and evaluate the

material properly. Auto radiators are sometimes "sweated" for removal of a portion of the solder and used for alloy brass. Auto radiators may be used in their original form after removing the iron by shearing. Wet concentration and blast furnaces are used chiefly for recovery of metal from industrial ashes, skimmings, slag, and miscellaneous copper-bearing residues.

Preparation of material for smelting or refining furnaces in which metal or alloy of high quality is produced requires careful and constant control. The grading and sorting of metal begins with the collector who buys all sorts of material each year from homes, house wreckers, and other primary sources. Large industrial organizations maintain salvage departments through whose hands millions of dollars' worth of scrap of all kinds is sold to smelters. Trained sorters at smelters become proficient in detecting the quality of brass and are competent in their judgment of the approximate composition when grading scrap metal.

Carefully graded scrap of known composition is charged into reverberatory furnaces, wherein it is melted, refined, and built up to specified composition. This process is essentially as follows: The base charge consists of about 50,000 lb. of copper, brass castings, borings, spatters, and bricked material of known composition. This is melted and brought up to a maximum temperature of 2,200 deg. F., the actual temperature depending upon the composition of the charge. The rest of the material is charged in quantities of 5,000 lb. or more, depending upon its nature. When the furnace is completely charged and the material melted, any slag that has formed is removed. The metal is thoroughly stirred and sampled. While waiting for the analysis, air is introduced into the molten metal and various impurities are removed. Slag-forming materials are added in carefully calculated quantities at this stage of the refining. The length of the blowing period depends on the impurities contained in the metal. Samples for analysis are drawn every hour to guide the metallurgist during the refining operation. Green poles are thrust into the metal to reduce the degree of oxidation, and control sample ingots are taken every ten minutes. A proper balance is maintained after poling by selective oxidizing or reducing agents. The desired composition of the metal is obtained by making necessary additions of copper, tin, lead, or zinc and the refined alloy is cast into ingots averaging 25 lb. each.

The furnaces, Fig. 1, in which the process outlined in the foregoing is carried on have a capacity of 40 to 50 tons per heat. Time required for charging, smelting, refining, and casting is governed by the nature of material and tonnage required. The furnaces are fired with two 2½-in. oil burners operating at 80-lb. pressure. Each furnace is equipped with an oil meter placed in the line ahead of oil-heating coils which heat the oil to approximately 150 deg. F. The air pressure on the burner is varied with the operating conditions, and ranges from 8 to 28 oz. A low-sulphur fuel oil is purchased on a zero cold test, maximum viscosity of 200 at 100 deg. F., 20 to 30 deg. Bé. Air-pressure, draft, and volume gages, and pyrometers, are a necessary part of the operating equipment. Gas analyses are made periodically to check the combustion on each shift.

The dust-collecting equipment is calculated to be of sufficient capacity to handle the gases and dust from three reverberatory furnaces, or two furnaces and a 42-in. blast furnace operating at one time. Computation determined the fact that a volume of 15,000 cu.ft. per minute, measured at 240 deg. F., would be required to carry the peak load under these conditions, and a twelve-compartment Dracco filter was recommended. A No. 29 Clarage exhaust fan, driven by a 40-hp. motor, was needed to induce this flow of gas. There was space beside the filter building for a radiation cooler with three U-tubes, 36 in. in diameter and 32 ft. high. In addition, the piping from the cooler to the filter building, and the long run of horizontal flue over the roof, served as radiation surface.

A vertical brick flue 30 ft. high is constructed over the low point of the arch at the throat of the three furnaces. On two furnaces the vertical flue is connected with the furnace by a short horizontal flue (See Fig. 1). The "verb" area, and the size of the furnace throat and flue, are calculated to insure high gas velocity from the furnace; a restricted throat (14x16 in.) insures an economic consumption of fuel oil.

Operating difficulties were chiefly due to excessive temperature in the steel branch flues. The ordinary 10-gage sheet steel used was inadequate, and the temperature was too high at the filters, making necessary chrome-nickel-iron alloy flue branches and a manifold. The alloy used resists oxidation with temperatures up to 2,100 deg. F. Also, it was necessary to install a spray chamber in which the temperature could be reduced with water from a high-pressure pump. The company supplying the filter equipment proceeded with these changes and made every effort to bring about efficient operation. Fig. 2 shows the spray chamber in the main flue directly in front of the center stack; discharge through the stack is eliminated.

A 20x54-in. rolled-plate chrome-iron damper, ½ in. thick, is placed in the vertical flue across the inlet to the branch flue, permitting draft control at each furnace. Rolled plates appear to withstand the action of the hot gases better, but they warp at the bottom. We have not yet obtained a cast plate of this size which has not cracked badly. The short life of the straight plate dampers caused us to design a butterfly damper of sturdy construction, reinforced with ribs, eliminating sharp corners, which we will test in a short time. We hope to gain more positive control with this type of damper, since leaks occur with the cracked and warped plates.

Fig. 3 shows the general layout of the present flue system as far as the spray chamber, and illustrates the manner in which the branch flues lead to the manifold "A." The damper previously mentioned is placed at "X." Pyrometric control was found necessary to preserve the life of the high-temperature-resistant steel branches, which are

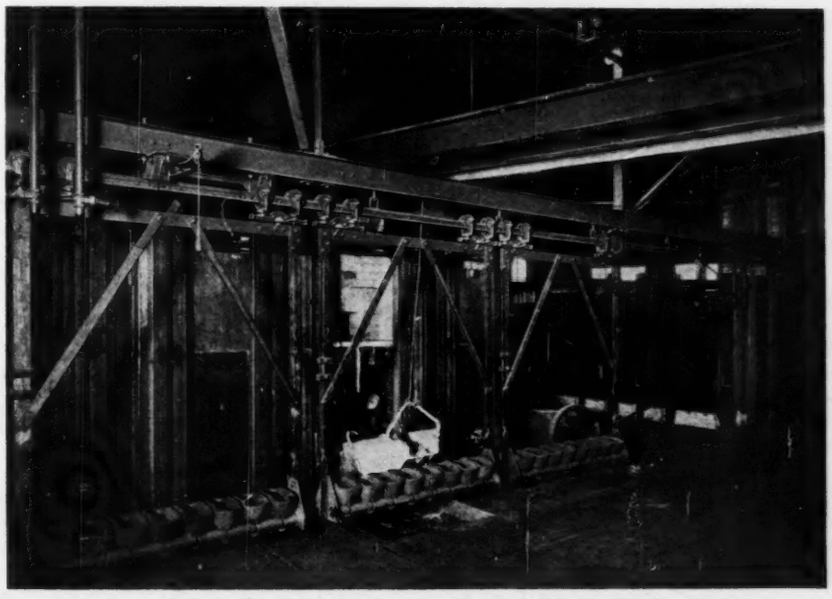
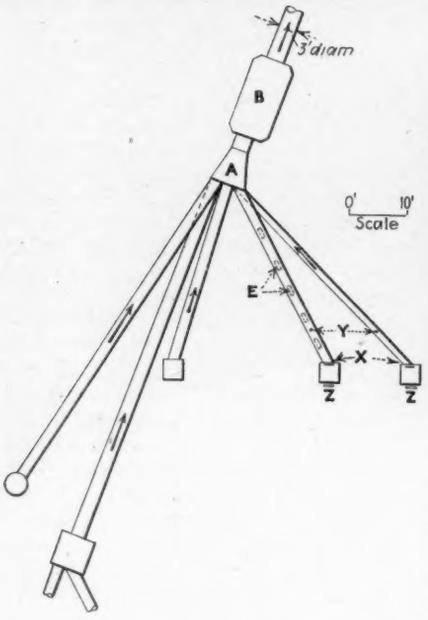
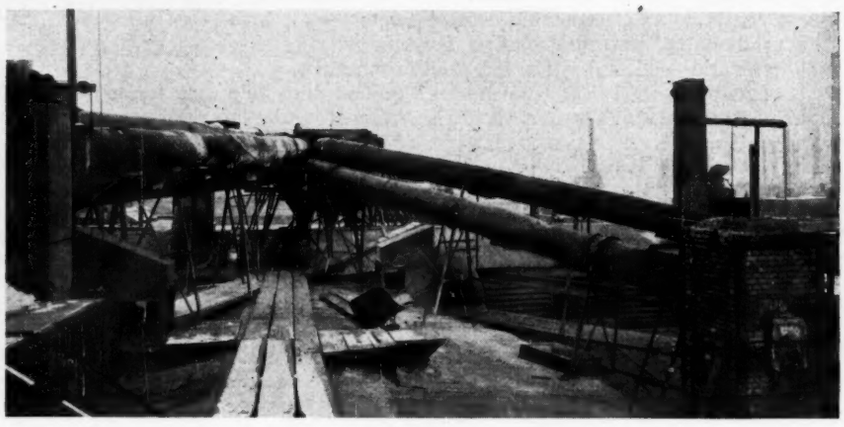


Fig. 1—Two 50-ton reverberatory furnaces, with pouring equipment

Fig. 2—Flue system, with fume filters and auxiliary equipment. Note absence of visible stack fume. Fig. 3, below, in halftone and diagram, shows branch flues, manifold, and spray chamber





expensive because of the alloy used and their high fabricating and welding cost This has aided in reducing consumption of fuel, and gives a reliable record of operating conditions which can be checked with the operating log. A thermocouple is inserted through the branch flues at point "Y," 10 ft. from the vertical flue. Thermocouple protection tubes presented a problem. Chrome-nickel tubes of ⅛-in. wall lasted only three weeks in the hot gases. After experimenting with various alloys and materials to obtain greater life of protection tubes, one was designed and cast of 27 to 30 per cent chrome-iron alloy which has lasted sixteen weeks.

Wires extend from the thermocouple to the foundry, where Leeds & Northrup (Type 8531X) recording pyrometers are installed, one for each furnace. The recorders are equipped with colored signal lights so that the foremen can correct a high-temperature condition without close scrutiny of the chart.

At point marked "Z" in Fig. 3 a brick tile door is hung, which facilitates cleaning the brick flue where incrustation of the oxide takes place. Incrustation is due to lowered velocity at this point and to the tendency for zinc and lead oxides to adhere and fuse to the hot brickwork. Zinc oxide adheres to almost any surface and builds up in layers until the expansion and contraction of the pipe lines cause the caked oxide to break away. The velocity of the gas is not great enough to pick up these solid plate particles, so hinged drop-doors, marked "E," are placed at 6-ft. centers along the bottom of each branch flue line to facilitate cleaning after each heat.

Some equalization of draft from the furnaces is accomplished by bringing each branch into a manifold chamber "A," which is connected with "B," the spray chamber. The spray chamber is 15 ft. long, 7 ft. wide, and 6 ft. high. (See Fig. 4.) Clean-out pipes, leading to a hopper constructed in the foundry, may be seen at each end. Several types of sprays and pumps were tried, but the one found most satisfactory with our conditions is a high-pressure Champion pump delivering water to stationary spray nozzles at 300-lb. pressure. At present, one nozzle is placed in each corner of the spray chamber (Fig. 4). The finely atomized mist is carried along with the hot gas and is largely absorbed. Any unabsorbed water noticed so far has precipitated in the spray chamber and not in the flue leading out of it. Each spray delivers two gallons of water per minute as adjusted. With four spray nozzles the cooling effect of the water is almost instantaneous, and a straight line drop is recorded on the filter inlet temperature control chart (to be described later). A typical chart is shown in Fig. 5.

The motor on the high-pressure water pump starts and stops with a Mercoid control valve, the tube of which is placed in the flue line at the inlet to the filters. The water supply to the pump is controlled by a Tagliabue direct-acting valve, which permits delivery of water to the pump at city water pressure when the inlet gas temperature is 5 deg. lower than that at which the Mercoid control valve starts the pump motor. By this means, running the pump without water is avoided, so if the spray is needed to reduce temperature, the pressure at the nozzle is quickly obtained. To protect the water from freezing we have extended a well-covered paralleling steam and water line to the spray chamber. This may be seen at the lower right-hand part of Fig. 4.

The spray chamber and the remainder of the flue system are constructed of ordinary rolled steel sheet. The flue from the spray chamber is a 36-in. diameter round pipe reduced to 30 in. 65 ft. from the U-tube coolers. Along this flue is a catwalk, shown plainly in Fig. 2. Unfortunately, the 6-in. round capped clean-out holes placed along this line cannot be seen. The main flue line is tapped with a rawhide mallet at intervals to loosen the caked oxide, which reduces radiation. A compressed-air pipe is put into the flue through these clean-out holes and the heavy oxide is blown into the cooler hoppers, from which it is removed. These are emptied once a day.

Incidentally, the paint used on the spray chamber, the main flue line, and the U-tube coolers has been made from the oxide collected in this equipment. The temperature of the gas in the flue has reached 1,200 deg. F. without materially affecting the paint coating. The lines were painted in April, and the cooler tubes were not fully painted with the second coat when the picture was

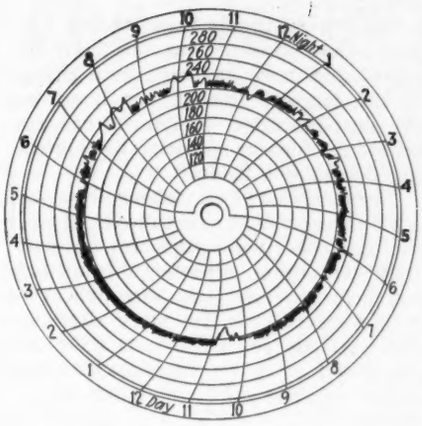


Fig. 5—Recording thermometer chart

taken in October. Though the paint was in good condition, the second painting was given before cold weather set in, to insure protection of the surface.

Fig. 6 shows the filter building with the bag collectors and auxiliary machinery. Each filter compartment consists of a sheet-metal cylinder in which are supported tubular cloth bags, open to the hopper below. The incoming fume enters first a balloon-section manifold, is drawn into the individual hoppers, and then up through the cloth bags. The solids are retained on the inside of the bags, and cleaned gas passes through the outlet manifold and exhaust fan. To remove the collected oxide regularly, a compressed-air-actuated cleaning mechanism is provided whereby each compartment in turn is automatically cut off the suction line by a damper. The whole set of bags is agitated rapidly, while a reverse current of atmospheric air assists in settling the loosened dust. The oxide falls to the hopper and through a 14-in. gate to the storage bin below. From the two bins, the oxide is delivered to bags through a short length of inclined screw conveyor, as can be seen in an accompanying illustration.

The construction of the filters makes it possible to cut off any one housing temporarily, without disturbing the operation of the rest of the unit, so that continuous 24-hour service is assured. Automatic cleaning makes possible a passing of as much as 4 cu.ft. of gas per minute through a square foot of filter surface, so that the equipment is much more compact than the stationary dust-collecting baghouse—one of the reasons which led to its selection. There is no visible dust in the discharge from the exhaust fan, and the collecting efficiency is 99 per cent.

Consumption of compressed air is about 50 cu.ft. of free air per minute, and a 5-hp. motor drives the compressor. The recording thermometer on the south wall serves to check the performance of the temperature-control devices. The three bulbs for these controls are indicated, two in the intake manifold and one bulb in the exhaust line. They are set so that at a gas temperature of 225 deg. F. at the filter intake, the water line to the pressure pump opens; at 230 deg. the pump supplies water to the sprays; and at 240 deg. the emergency inlet damper opens to cool the gas with atmospheric air.

The temperature at the filters should not exceed 240 deg. for any length of time, and 230 deg. is the recommended operating temperature. If the woolen bags were subjected to gas at a temperature of 275 deg., they would be scorched and the life of the fabric reduced. An electrical contact has been placed on the atmospheric air inlet damper so that a red light burns in the foundry when this opens. The foreman is immediately aware of the high temperature at the baghouse, and promptly investigates to see if all the mechanisms are functioning, and makes such adjustment as may be necessary. The inlet damper is only an emergency cooling device, since its use greatly reduces the draft at the furnace.

The static loss across the filter equipment is about 4 in. of water, and is checked regularly by reading the manometers placed in the intake and exhaust lines. Static readings are also taken regularly along the main flue, to check the resistance of the piping and cooling tubes.

Improvements have been made to the safety damper inlet pipe and to the control mechanism, which were placed on the outside of the building owing to lack of space. (Fig. 2.) An elbow has been placed over the inlet, so that snow and ice cannot freeze the damper. The galvanized iron box shown over the control mechanism above the safety damper pipe serves the same purpose.

The oxide is sampled and the accumulation from each day's operation is given a lot number and stored separately. A bag of dust may vary in weight from 15 to 60 lb., and in color from near white to dark gray. The color of the oxide is due chiefly to the carbon present, influenced by excess oil burned, oil or grease on metal charged, and to draft. Good draft means lighter colored oxide; whereas, a reduced draft causes darkening. The reduced draft is usually caused by blocking of the flue lines at some point.

The average analysis of No. 1 oxide, and the extreme variations, over an eight-month period show:

	Average Per Cent	Limiting Percentages
Copper	0.32	0.05 to 1.00
Tin	0.95	0.07 to 10.69
Lead	7.86	2.31 to 29.48
Zinc	69.40	48.05 to 76.70

During the last sixteen months' operation 3,400 lb. of dust was recovered per furnace per operating day of 24 hours. Production over a period of 13½ months amounted to 1,237,000 lb. of No. 1 oxide and 286,000 lb. of No. 2 oxide. No. 1 oxide, the filter product, is used for paint pigment, chemicals, and for reduction to metal. The No. 2 oxide, about 60 per cent zinc, is made up of the cooler accumulation, the branch cleanings, and other like materials, and is used by zinc producers with their ore for reduction to metal. Only 65 per cent of the dust available for collection was filtered, owing to the time required for alterations, which was lengthened materially by bad weather conditions. Had all the available dust been filtered out, approximately 2,300,000 lb. of oxide would have been produced.

The direct operating expense for the period was greater than is expected in succeeding years. This, together with the decrease in price of zinc residue, has caused the equipment to show but little return on the investment so far. However, as the value of the oxide increases the installation should pay for itself, and other savings also can be credited to the dust-collecting equipment. A minimum reduction of 15 per cent on oil burned has been effected, so, with an

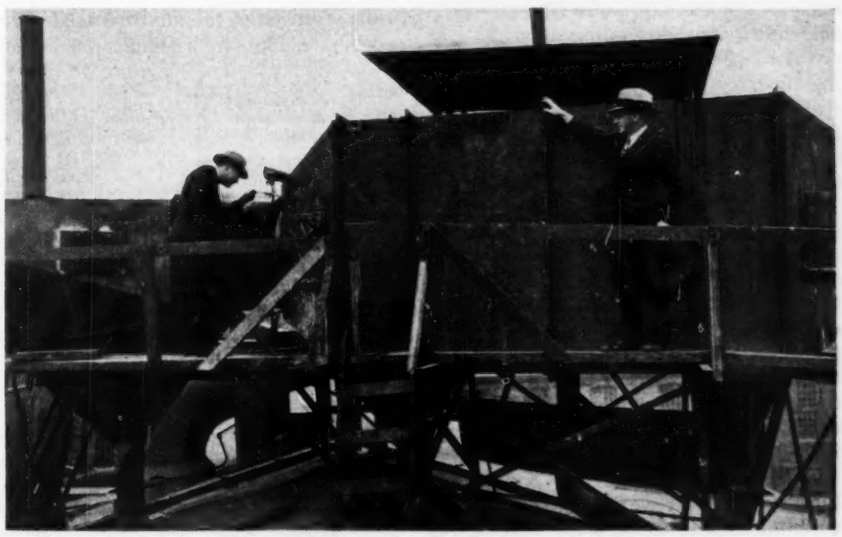


Fig. 4—Adjusting one nozzle at entrance to spray chamber

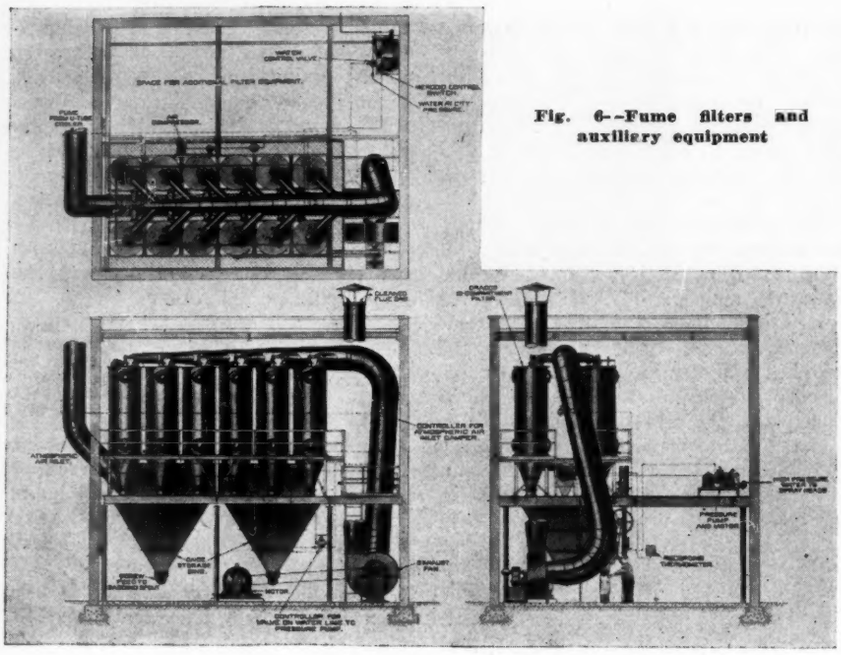


Fig. 6--Fume filters and auxiliary equipment

average daily use of 1,800 gal. or more, a tangible saving is made there. Our production schedule has not been impaired and there has been little change in the tonnage smelted per hour, but the dust-collecting equipment has stabilized the furnace operation by eliminating fluctuations in draft.

Those in charge of melting were first a bit antagonistic toward operating with the dust-collecting equipment; however, with everything adjusted, this attitude has been reversed. In fact, whenever it is necessary to use stack draft for short periods, relief and satisfaction are registered when the furnaces are once again "hooked up" with the dust collector.

The elimination of the dust and smoke nuisance in the vicinity of our plant, in compliance with the smoke ordinances, is of considerable importance to the health and well-being of the people of the community.

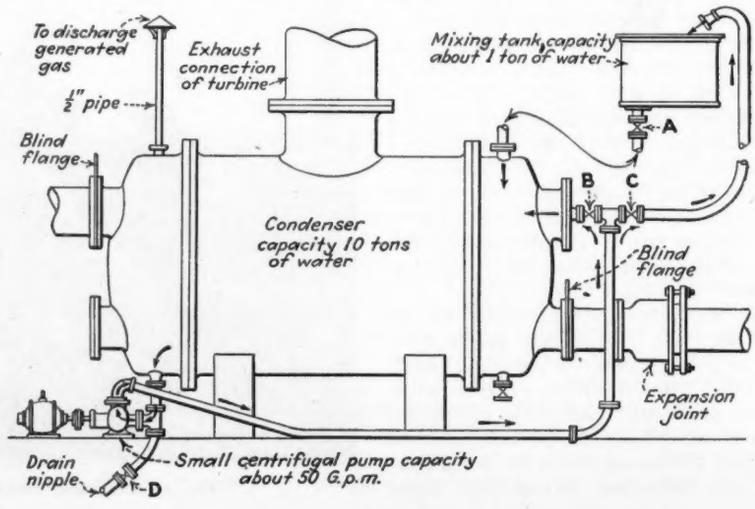
Chemical Removal of Incrustations

AN important item when overhauling steam turbines, air compressors, and other water-cooled machinery is the removal of scale and incrustations, at regular intervals. This may be done in two ways: by hand, using round steel brushes and scrapers, a laborious and costly task requiring long time and frequent replacement of tools, or chemically, a more rapid and thorough method when correctly applied. The chemical process, as described here, has been used for several years in the power stations of many European mining companies, and has been found economical and efficient.

The equipment required consists of a small centrifugal pump, a mixing tank, and pipe connections and fittings, of suitable dimensions, depending upon the size of the machine to be cleaned. It may be installed temporarily or permanently, if space is available. A condenser with a capacity of 10 tons of cooling water requires a mixing tank of exactly one ton's capacity, to permit correct mixing and feeding of the compound, which should contain from 2,400 to 3,000 lb. of hydrochloric acid, 24 deg. Bé., to every 10 tons of water, a formula previously determined by tests. A pump of about 50 g.p.m. is required to circulate the mixture slowly through the condenser. The position of the mixing tank, pump, valves, gas discharge, and drain pipes is shown in the accompanying illustration.

After the turbine has been shut down, the valves on the water lines are closed, or blind flanges are inserted if no valves are used. The mixing tank is then filled nine times with pure water, a total of 9 tons of water, which is discharged into the condenser by opening valve *A*, keeping valve *D* closed. Valve *A* is then closed and the mixing tank half filled with water. The bottled hydrochloric acid is added slowly to the water to avoid a rapid rise in temperature and to prevent splashing. Valves *A* and *C* are then opened, valve *B* closed and the pump is started, after which valve *A* is regulated to keep the mixing tank a little more than half filled until the last bottle of acid has been added. Valve *C* is then closed and valve *B* opened, and the compound is circulated, until the incrustation is dissolved, which requires from 1½ to 3 hours, according to the strength of the mixture used. The progress made can be determined from time to time by the amount of generated gas discharged from the ½-in. test pipe, or by again passing the compound through the mixing tank by closing valve *B* and opening *C*. With some experience the condition of the condenser tubes can easily be estimated from the amount of mud contained in the mixture. Finally, the pump is stopped, all valves are opened, and the muddy liquid is allowed to drain through the nipple connected to valve *D*.

With this method, used every two months for the last two years, the five days usually required to clean the condenser and to perform minor repairs was cut to 36 hours, with a considerable saving in labor and materials. As the metal is exposed to the acid for only a short time, no corrosion of any part, including packings, has been observed to date, although, at times, temperatures up to 45 deg. C. have been reached.



The Labor Factor in Gold Mining

S. D. Strauss

Assistant Editor

IN SPITE of the industrial depression, the business of giving advice on problems of currency control prospers. Factories, farms, and mines may be abandoned, stock markets may crash, and unemployed by the thousands walk the streets, but the publication of articles advancing the relative merits of gold or silver or paper or good faith as standards of value goes merrily on. To that endless discussion I have no intention of adding. If a shortage of gold is imminent, however, perhaps an examination of the reasons for the decline of production from at least one important gold field (reasons that can probably be applied with equal merit to other waning gold districts) may help to stimulate thinking about the necessary steps for increasing production.

Western Australia is known as a gold-bearing country. Few would assert that its resources of gold have been exhausted. Yet in 1929, production was only 372,064 oz. of gold from 703,808 short tons of ore, or an average recovery of 0.53 oz. per ton. Twenty-five years ago, in 1905, the same province produced 1,840,656 oz. of gold from 2,960,634 short tons of ore, an average of 0.67 oz. per ton. Not only is this situation distressing because of its possible bearing on the currency system now generally used in Occidental countries, but because it has meant a great loss to the state itself in wages. In 1905, 16,832 men were employed in gold mining in Western Australia; in 1929, only 4,002 men were so employed.

The record of the Witwatersrand, South Africa's great gold-producing area, is precisely the converse. In 1905, production was 4,706,433 oz. of gold from 11,160,422 short tons of ore, or an average of 0.42 oz. of gold per ton. In 1929, production was 9,980,713 oz. from 30,502,800 tons of ore, an average of 0.32 oz. per ton. Employment increased from a total of 147,995 men (both white and black) to 213,505 men.

Why should the Witwatersrand forge ahead? Why should Western Australia fall behind? The chief factors in gold production are two: The presence of gold and the cost of obtaining it. Both the Witwatersrand and Western Australia possess reserves of gold-bearing material. In the former, the orebodies are more consistent, but they also extend to such great depths that their development and equipment are both costly and hazardous. The cost of extraction has probably had more to do with the production of the two fields than this difference in the character and availability of the deposits. On the Witwatersrand, large tonnages averaging more than 4.5 dwt. of gold per ton constitute ore, whereas in Western Australia the gold content must usually be more than 8 dwt. to insure a profit. This higher cut-off point, caused by higher costs and complexity of ore character, has eliminated much gold-bearing material from possible exploitation.

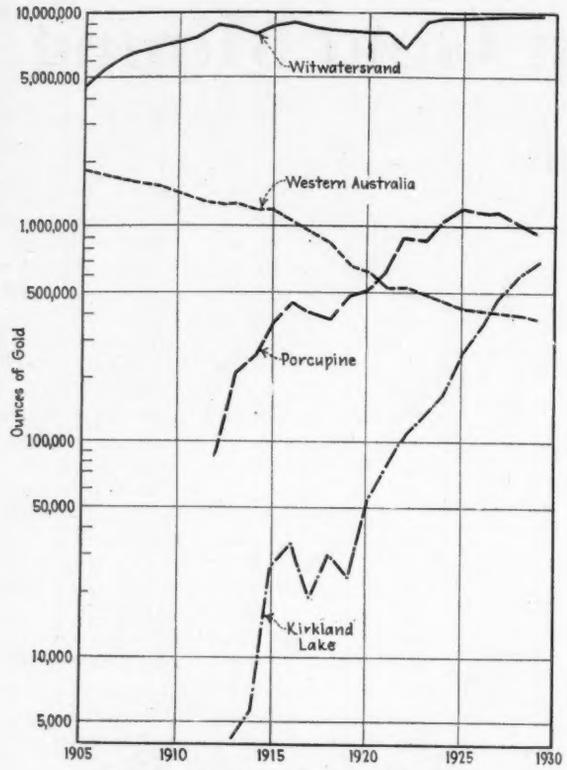
Because most of the Western Australian mines are now being worked by leasers, adequate cost data are not available for 1929. In his speech delivered at the annual meeting of the Chamber of Mines of Western Australia, R. Hamilton, president of the organization, gave cost figures for 1926 and 1914. In 1926, to mine and mill a ton of gold ore in Western Australia cost an average of 32s. per ton. In the same year, the average cost on the Witwatersrand was 19s. per ton. This large spread between the two districts did not exist in 1914, when Western Australian costs were 20s. per ton and Rand costs were 17s.

One of the most familiar aspects of gold mining is its sensibility to general industrial conditions. When commodity prices are high, when wage scales increase, taxes rise, and supplies become dearer, the gold miner must effect drastic economies in operation or close his mine. The World War resulted in all these conditions. In 1920 and 1921, the cost of living, all over the world, was higher than it had ever been before, expressed in terms of the gold standard. Mr. Hamilton concludes that the drop in Western Australian gold production results from the increased cost of living, and he is probably right. But what of the Witwatersrand? Why has gold production of that district continued to increase? The apparent answer would be that South Africa was immune to world conditions, that the World War failed to increase wages, taxes, or the cost of supplies. Consultation of the statistics for the years 1914 and 1926 shows clearly, however, that increases in living and other costs did take place in South Africa, although they may not have been as great as in other parts of the world. The scale of wages in the gold-mining industry during that period rose about 20 per cent, taxes rose 40 per cent, and the cost of supplies per ton of ore treated rose 17 per cent.

Here, then, are two areas, both of which have available large quantities of gold-bearing material, both of which have been large gold producers in the past, both of which have showed a gradual tendency to mine lower-grade ore (the drop in both instances was about 25 per cent in 25 years), and both of which have been subjected to increasing taxes, cost of supplies, and wages. What is the magic formula that has permitted the one to expand while the other seems to be rapidly approaching oblivion? It can be found in the accompanying table headed "Labor Efficiency." The figures given there have been obtained by dividing the average number of men employed in the given year—underground, on the surface, and in metallurgical plants—into the total tonnage (short tons) milled and into the total number of ounces of gold produced.

The table shows that both from the standpoint of tons of ore produced per man per year and of ounces of gold produced per man per year, the Witwatersrand has steadily increased. Western Australia, on the contrary, has fluctuated and is now actually obtaining less revenue per worker employed in its gold mines than it did in 1905, although it is paying that worker considerably more! In justice, it must be explained that the Western Australian figures for 1929 are probably unusually low because of the large number of men employed in non-productive work at Wiluna Gold. Also, because of the complex character of the ore at Kalgoorlie, where metallurgy was well advanced at the beginning of the century, marked improvements in milling practice have been difficult. Still, had metallurgy held its own, adoption of modern methods of mining and transportation would apparently effect notable increases in the tonnage handled per man. The evidence indicates that in the last 25 years Western Australia has derived little, if any, advantage from improvements in mining technology. The record of the Witwatersrand shows the effect of such improvements on other fields.

Perhaps the comparison between the Rand and Western Australia may seem unfair because of the fact that the Rand has the advantage of tremendous numbers of cheap colored workers. It must be admitted that all the Witwatersrand mines could not operate if they had to pay white men wages of more than £1 per shift for mining 143 tons of ore per year. But, on the other hand, white workers would probably mine much more than 143 tons a year. To support this statement, figures for the Porcupine and Kirkland Lake areas, in Canada,



Gold Production Chart, 1905-1929

Labor Efficiency

Expressed in Tons of Ore and Ounces of Gold per Man-Year

	Western Australia		Witwatersrand		Porcupine		Kirkland Lake	
Year	Tons	Oz.	Tons	Oz.	Tons	Oz.	Tons	Oz.
1905	176	109	75	33	...	...	...	...
1906	194	105	88	36	...	...	...	...
1907	209	104	90	36	...	...	...	...
1908	228	105	102	38	...	...	...	...
1909	217	98	108	37	...	...	...	...
1910	209	92	103	36	...	...	...	...
1911	207	90	111	37	...	...	...	...
1912	228	96	118	40	185	111	...	...
1913	239	99	123	41	296	191	55	37
1914	258	104	136	43	406	190	28	43
1915	266	109	131	41	467	175	199	205
1916	254	108	126	40	584	200	214	179
1917	257	112	133	42	537	187	194	77
1918	237	113	123	40	504	234	204	117
1919	205	98	123	42	565	251	204	117
1920	202	90	122	40	686	304	420	230
1921	164	90	121	40	646	260	262	142
1922	172	96	112	39	763	328	446	243
1923	163	93	135	45	582	237	384	332
1924	171	89	142	47	628	256	355	263
1925	182	88	144	47	682	272	426	290
1926	202	98	145	47	686	248	465	309
1927	196	102	140	47	777	258	537	315
1928	189	104	140	46	719	222	538	307
1929	176	92	143	47	688	224	515	318
Change, per cent.	0	—18.5	+91	+42	+47a	+28a	+22a	+38a

(a) For Porcupine, the gain is shown over the fifteen-year period starting in 1915, and for Kirkland Lake it is shown over the ten-year period starting in 1920.

have also been given. Both of these fields are new and the latter is comparatively high-grade, but the tonnages produced per man per year look remarkably impressive next to the Western Australian record. Wages are little lower in Western Australia than they are in Canada (the basic wage in Australia is now £4 7s. per 44-hour week, or about $4 per eight-hour shift). In other words, the miner at Kalgoorlie is paid nearly as well for producing from one-third to one-quarter of the tonnage and one-half to one-third the gold that the miner at Timmins or Kirkland Lake produces.

Of the justice of high wages and short working hours so much has been said that, in the United States at least, they are taken as the cardinal principles of prosperity and democracy. Of what use is the invention of a labor-saving device if it does not effectively add to the leisure and wealth of the worker? In Western Australia, the peculiar spectacle is presented of a system that has raised wages and shortened working hours with little increase in production per unit of worker's time. The employer will say that that is the fault of the labor union and that, if fewer men are now working in the gold mines than in former days, the policy of compulsory arbitration of labor disputes that has ended inevitably in granting at least part of all labor's demands is the cause. He will say that wage increases should have come only after output per worker per unit of time had been increased, but there is another angle to the question. Perhaps the worker has not been provided with the tools wherewith to increase his output. Perhaps the gold producers in Western Australia have been too ready to pay profits out in dividends without considering the introduction of new and more efficient methods and more productive machinery.

If this assumption—that gold mining in Western Australia has suffered because the operators have not kept pace with improved methods of production—is true, it should be reflected in the results obtained by Wiluna Gold and Lake View & Star, both of which are adopting large-scale modern methods at their properties. The success of these two enterprises may do much to put Western Australian gold mining on a more satisfactory basis, even if it cannot compete in output with Canada or the Witwatersrand.

■ ■ ■

The labor factor in gold mining—at work in a small property in the Peruvian Andes

Suspended Crusher Replaces Rolls

New unit at Bird Dog mill in Tri-State zinc-lead district effects marked economies in hard-iron and power consumption, besides making possible large-tonnage operations

H. D. Keiser

Assistant Editor

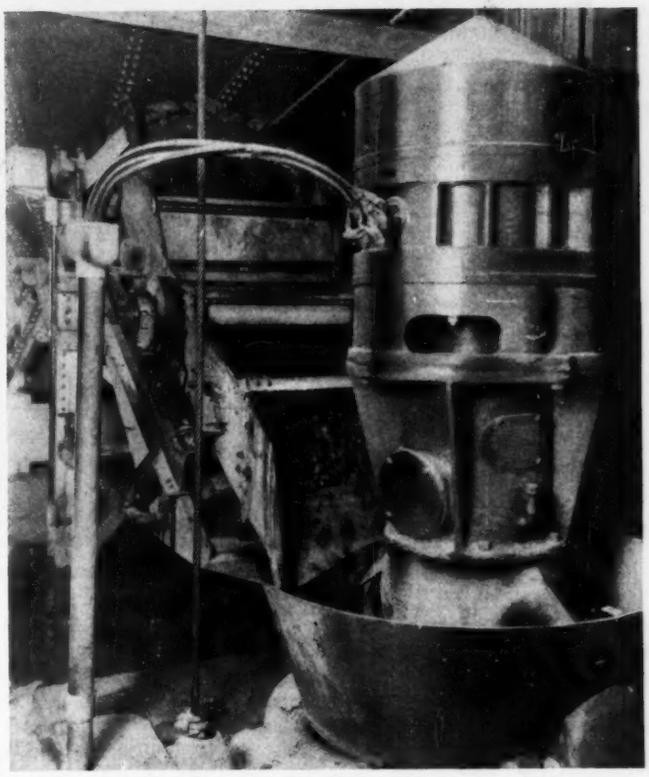


Fig. 1—Upper part of Newhouse crusher at Bird Dog mill; 1-in.-square-mesh screen and belt feeder, discharging ore from the mill hopper, are seen to the left of the crusher

HARD-IRON rolls, known as dirt rolls, that vary in diameter up to 61 in., are commonly employed in the Tri-State zinc-lead district for crushing, immediately following initial reduction of the ore in a jaw breaker. Numerous attempts have been made to replace these rolls with secondary crushers of other types. Such efforts, however, have been unsuccessful until recently, when the installation of a 7-in. Newhouse suspended crusher at the Bird Dog mill of the Commerce Mining & Royalty Company effected marked economies in hard-iron and power consumption, besides aiding materially in achieving operations on a larger scale than ever before practiced in the district.

Installation of the crusher followed a crushing test and a comparison of the results of this test with the performance of dirt rolls in another mill of the company. In making the test with the Newhouse crusher, the feed consisted of 1,000-lb. of Tri-State ore, all of which was plus 1-in.-square mesh, some pieces being as large as 4x6x10 in.

Two roll tests were made, individual 100-lb. samples of both the feed and discharge being taken hourly during one mill shift. In the first test the rolls were spaced at $\frac{1}{4}$ in.; a total of 9,088 tons of ore had already passed through them. Inasmuch as an average of 52,540 tons of ore had been crushed with each of the two preceding sets of dirt rolls, the assumption was made that the rolls were 17.3 per cent worn, although no indications of grooving were apparent. A total of 16,036 tons had been ground in the rolls when the second test was made, and the assumption therefore was that the rolls were then 30.5 per cent worn. The spacing of the rolls in this test was a minimum of $\frac{1}{8}$ in.

Results of a screen analysis of the crusher product and of calculations of the reduction effected by the rolls, based on screen analyses of the feed and discharge samples, are shown plotted as curves in Fig. 3, on the next page. The following conclusions were drawn from these test data:

1. Crushing efficiency of the rolls decreased markedly as the wear increased from 17.3 per cent to 30.5 per cent. This was to be expected, because grooving of the rolls began soon after the first test. Moreover, inasmuch as weight of the rolls is an important factor in crushing, the gradual reduction in weight of the rolls by wear was accompanied by decreased crushing ability. Therefore, with more pronounced grooving that would develop with continued use of the rolls, a corresponding decline in crushing efficiency might be expected.

2. Crushing efficiency of the Newhouse crusher exceeded that of the rolls, even when the rolls were practically new. This superior efficiency of the Newhouse unit should not decline as the faces of the crushing parts become worn, because performance of the unit is not dependent on the weight of the reciprocating parts.

Installation of the Newhouse crusher at the Bird Dog mill was made with a guarantee that hard-iron cost would not exceed 1c. per ton of feed to the crusher; power consumption was not to be more than 0.96 hp. per ton per hour; capacity was to be at least 60 tons per hour, with a 1-in. discharge opening.

An actual operation test for the period of a week was made soon after completion of the installation. Feed to the unit consisted of the oversize of a 1-in.-square mesh screen; the opening was set at 1 in. During the period the plant milled a total of 4,557 tons of ore in 51 hours, or 89.3 tons per hour. Tonnage tests showed that the Newhouse crusher feed averaged 52.5 tons per hour, or, in other words, 58.8 per cent of the feed to the mill was plus 1-in.-square mesh. On the basis of 116 tons per hour, which is the maximum milling rate that has been maintained at the mill for a period of a week, the Newhouse crusher must therefore have handled 68.2 tons per hour, or 13.6 per cent more than the guaranteed capacity. This rate of crushing, in the opinion of many experienced operators of the district, is much greater than that possible with any set of dirt rolls, as commonly employed.

A conservative estimate of the life of

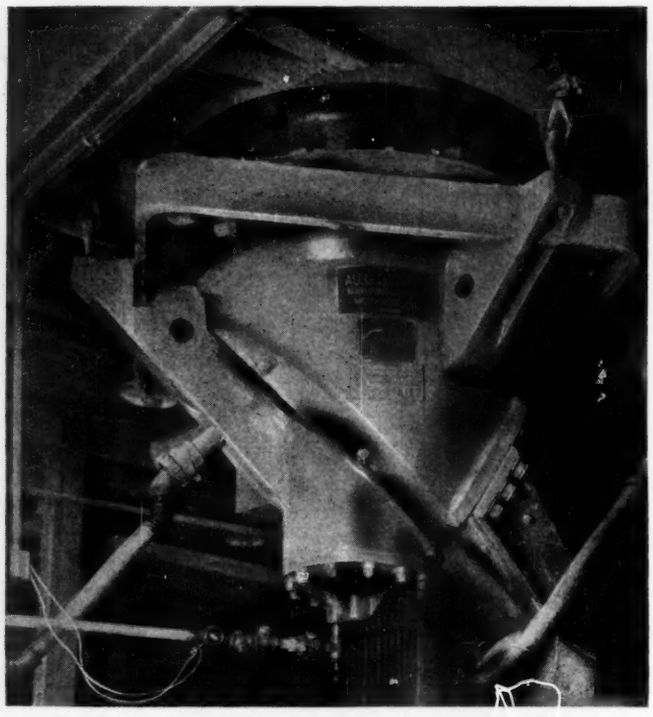


Fig. 2—Lower part of Newhouse crusher installation at the Bird Dog mill

one set of crusher concaves, based on observed wear, is 112,000 tons of mill feed. Concave-wear cost, on this basis, is 0.14c. per ton. The life of one mantel was 58,985 tons of mill feed, and the mantel-wear cost was 0.32c. per ton. Total hard-iron cost per ton of mill feed is therefore 0.46c.; or 0.78c. (0.46 ÷ 0.5883) per ton of feed to the crusher, as compared with 1c. specified in the guarantee.

Power consumption averages about 40 hp. At the average milling rate of 110 tons per hour, the crusher feed is about 64.7 tons, and the power required per ton of feed per hour is therefore 0.62 hp., as compared with 0.96 hp. set forth in the manufacturer's guarantee.

In comparison with dirt rolls, the aforesaid hard-iron and power economies achieved with the Newhouse crusher represent in a year, at an average milling rate of 100 tons per hour for ten hours per day for 300 working days, a saving of $3,695. This saving, however, is of minor importance compared with the large milling capacity of the plant that the crusher largely provides.

Unlike other crushers, the Newhouse is supported by three cables, which absorb much of the vibration and shock of crushing that would otherwise be transmitted to the mill structure. In addition, shearing of foundation bolts is, of course, avoided. As shown in Fig. 4, design of the crusher differs markedly from that of other gyratory units. For instance, the driving motor is directly connected to the eccentric. This feature causes the eccentric to rotate and the crusher head to gyrate at the same speed as that of the motor. The top end of the mantel is stationary, whereas the bottom end, through the operation of the eccentric, is moved in a small circle, the diameter of which depends on the pitch given to the eccentric. The mantel does not rotate.

Speed of operation is about 720 r.p.m. Lubrication for the eccentric is provided by a combination oil filter, cooler, and storage tank, installed near the crusher on the ground floor of the mill. A small motor-driven centrifugal pump forces filtered oil through piping, with flexible connections, to the bottom of the eccentric. The oil returns by gravity from the top of the eccentric to the filter. An

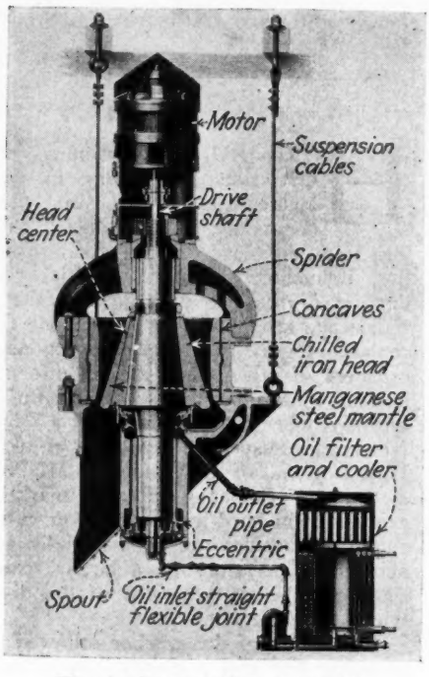


Fig. 4—Cross-section of crusher

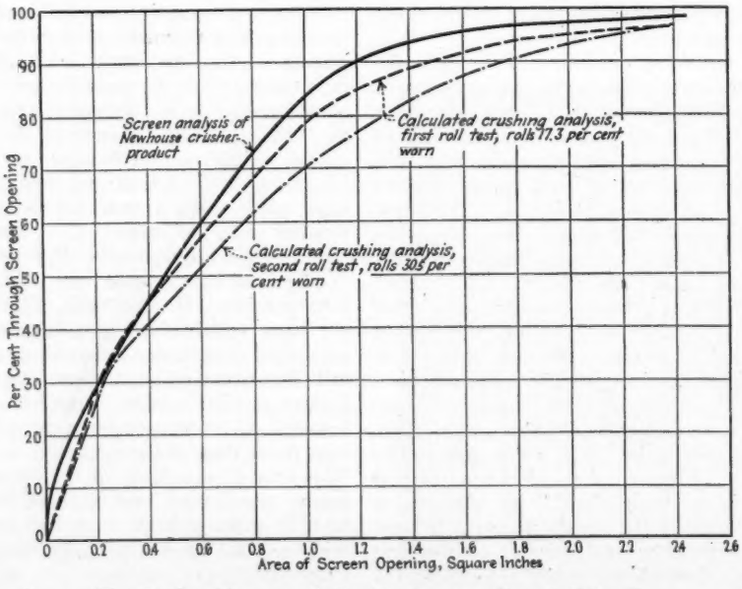


Fig. 3—Crushing curves for Newhouse unit and dirt rolls

electric relay connected to the oil line stops the crusher motor if the flow of oil should be interrupted. In this manner the eccentric bearing is protected from damage. This relay also actuates a siren to attract the attention of the operator.

Among other outstanding features of the Newhouse crusher, which is made by the Allis-Chalmers Manufacturing Company, are: Small number of working parts; absence of all gears and belts; reversible concaves; low oil consumption; accessibility of moving parts.

Acknowledgment for the information, photographs, and drawings presented in the foregoing account is made to Mr. Elmer Isern, metallurgical engineer, Commerce Mining & Royalty Company, who provided this material at the time of my recent visit to the Bird Dog mill.

Progress in Flotation Practice and Equipment

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THE TONNAGE of ore annually treated in the world by the flotation process has now passed the 100 million mark and is increasing. The chemicals used in this connection amount to approximately 300,000,000 lb. annually in the United States alone. Flotation is therefore of great importance not only to the mining man but also to the chemist who supplies the reagents.

The following recent developments in flotation technology appear to be among the most significant.

Only a few years ago the idea of floating a non-metallic mineral was hardly in accord with accepted theory. It was found, however, that many non-metallic minerals would float if treated with the proper chemicals, and now, non-metallic flotation is being carried out successfully on a mill scale. The tonnage of non-metallics being treated by flotation is relatively small as yet, but as the resources of high-grade non-metallic ores decrease, this type of flotation is likely to come into more general use. Among the ores that have been treated by this process are the following:

Manganese — Within the past year a 300-ton plant was erected at Anaconda, Mont., for the flotation of manganese carbonate (rhodochrosite) ore from the Emma mine, in Butte. Laboratory tests conducted by the U. S. Bureau of Mines have also indicated the possibility of floating the manganese oxides, pyrolusite, manganite, and psilomelane, though these are not nearly so floatable as rhodochrosite.

Phosphate Rock—Several years ago the U. S. Bureau of Mines, and others, carried out successful experiments with the flotation of phosphate rock. Last year a 1,000-ton plant was put into operation by the International Agricultural Corporation, Mulberry, Fla. The material treated is a low-grade washer product, formerly sent to waste. Inasmuch as the process is covered by patents, issued and pending, little or no information concerning the chemicals used or the process has been published. I have been told that a modified cascade type machine, similar to that formerly used in Australia, has been found particularly suited to the coarse material treated.

Fluorspar—The Franklin Fluorspar Company, Rosiclare, Ill., is operating a 50-ton flotation plant making a high grade of acid spar. The reagents used are sodium oleate and cresylic acid.

Baryte—At Barstow, Calif., a baryte-bearing tailing, containing approximately 25 per cent of baryte, is being successfully treated by flotation at a rate of 125 tons per day. The plant consists of one 10-ft. K&K double spitz rougher machine and one 10-ft. K&K single spitz machine for cleaning. The concentrate contains 94 per cent $BaSO_4$, 1.5 SiO_2, 4.0 $CaCO_3$, and 0.6 per cent iron oxide. The process is protected by patents held by the Tonopah Mining Company of Nevada.

Coal was successfully floated on a laboratory scale several years ago. Recently one of the large coal companies [the Pittsburgh Coal Company—EDITOR] has taken active interest in coal flotation and there is a strong possibility that a unit of commercial size may soon be in operation.

Other non-metallic minerals that have been floated on a laboratory scale are: bauxite, mica, calcite, kaolinite, and feldspar. It is evident, therefore, that even those minerals which in their natural state have little or no floatability can be made to float when treated with the proper chemicals.

The flotation of non-sulphide metallics, such as the carbonates of lead and copper, by sulphidizing, is not particularly new. Several plants have attained a high degree of success, among them American Smelting & Refining in Mexico; Chief Consolidated at Eureka, Utah; and the International Smelting Company, Tooele, Utah, treating oxidized lead-silver ores from the Tintic district, and the first custom plant of its kind to treat such ores.

The International practice is briefly as follows: The sulphide lead and silver, which occur in small amount, are floated first by Aerofloat 15 and ethyl xanthate; then the oxidized lead and silver minerals with sodium sulphide and amyl xanthate. To get the best results it is necessary to add sodium sulphide to each cell of the machine and to follow this immediately with amyl xanthate. This would seem to indicate that the action of the sodium sulphide is not only rapid but also of short duration. About 5 lb. of sodium sulphide and 1.5 lb. of amyl xanthate are needed.

This procedure, although it does excellent work on Tintic ores, has not given satisfactory results on several other ores of similar type.

Within the last two years the research staff of the American Cyanamid Company has devoted considerable time to a study of the fundamentals of non-sulphide flotation. Among other things discovered is the fact that when certain chemical promoters are used, it is not necessary to coat the mineral with a sulphide film.

Flotation has been adopted by every plant in the Michigan copper country during the last three years, and a large quantity of native copper formerly sent to waste with the gravity tailings is now being recovered. Concentrates running from 50 to 60 per cent copper are being produced from tailing of 0.30 to 0.60 per cent copper. Flotation tailings as low as 0.05 per cent are common in the district. Aerofloat 25, Reagent 208 (one of the solid, non-frothing Aerofloats), and ethyl xanthate are the promoters used.

Although, for the present, the floating of metallic copper is confined to the Michigan copper country, recent developments in the treatment of low-grade oxide copper ores indicate that another field may be opened. In Northern Rhodesia a new process under development reduces the copper to the metallic state, and then separates it by flotation. The ore, ground to 10 mesh, is heated to remove moisture and other volatile constituents. Then the calcine is mixed with 1 to 2 per cent of coal and about 0.5 to 1.0 per cent of common salt and heated to 600 to 700 deg. C. in a reducing atmosphere, reducing the copper to the metallic state. The charge is then chilled, reground, and sent to flotation. Microscopic inspection of the flotation concentrate shows the copper to be present as fine metallic grains in association with small quantities of carbon and a negligible amount of gangue. The advances recently made in the flotation of metallic copper have been valuable in the development of this process.

Flotation can be utilized in the treatment of gold-silver ores in several ways. For example, flotation, followed by cyanidation of the flotation concentrate, is particularly applicable when the precious metals are partly free and

A paper recently read before the New York Section, A.I.M.E.

partly in intimate association with sulphides such as pyrite or arsenopyrite. Frequently the gold- and silver-bearing sulphides can be floated at a coarser size than cyanidation would demand, with subsequent re-grinding of the flotation concentrate, constituting only a small portion of the original ore, before cyanidation. During the last year the McIntyre Porcupine Mines, Limited, one of the older cyanide operations in Canada, investigated this scheme of treatment. Their experimental results indicated that flotation, followed by cyanidation of the flotation concentrate, is more economical than straight cyanidation; so their new mill, now under construction, will follow this scheme. The cyanide consumption is said to be the same with both methods of treatment.

Two large gold-mining companies in Western Australia have conducted similar successful tests, and plants are now under construction. At one of these properties the ore contains $7 to $8 in gold as sulphotelluride in association with pyrite and arsenopyrite. Flotation of the ore at 120 mesh yields 90 to 94 per cent gold recovery with a ratio of concentration of 8 into 1. The concentrate will be roasted and cyanided.

Also, another property in Australia has completed its pilot tests and is constructing a plant. The ore contains about 5 per cent sulphides, principally pyrite mixed with stibnite, arsenopyrite, chalcopyrite, and tetrahedrite. The gold content averages about $8.40. It is estimated that 8 per cent of the crude ore will be recovered in a flotation concentrate assaying approximately $100 gold per ton. This concentrate will be dried, roasted, and cyanided.

A few amalgamation or cyanidation plants have changed to straight flotation. An example is a California operation whose ore averages $10 in gold, associated with pyrite and a little galena. The flotation concentrate assays $340, and the tailing $0.75 in gold. A further example of successful treatment of an ore relatively high in pyrite is a plant near Helena, Mont., which recently changed from all cyanidation to flotation. The following results are being obtained:

Material	Gold Oz.	Per Cent Iron	Per Cent "Insoluble"
Feed	0.34 to 0.40	7.0 to 12.0	
Concentrate	7.00 to 9.06	40	7.0
Tailing	0.03	3.5	

The flotation tailing is tabled for the recovery of the coarse gold that has not been floated.

In the Cobalt district, Ontario, flotation has been used for some time in the treatment of silver ores. For example, at the plant of the Cobalt Reduction Company, the gravity slime, containing 9.0 oz. silver (mostly native), is floated. The concentrate averages about 1,200 oz. silver and the tailing about 1.5 oz. Aerofloat Reagent No. 208 is the promoter used.

Adoption of alkaline circuits; introduction of chemical promoters, such as ethyl xanthate and the Aerofloat reagents; and the use of cyanide have improved the efficiency of the flotation of sulphide ores so much that the most complex can now be successfully treated. The old cut-and-try methods are no longer tolerated. Systematic research has been substituted for empirical testing.

In the last two years a great deal of study has been devoted to fine grinding and classification. To obtain good metallurgical results, the flotation circuit must be furnished with a pulp of proper density and fineness. Minerals that have not been liberated cannot be separated.

In studying the function of promoters it has been found that all compounds of a certain type have a characteristic promoter effect. For instance, compounds of one type may exhibit marked ability to promote the flotation of coarse mineral grains or mixed grains. Compounds of another type may have a marked tendency to float extremely fine minerals. By using two promoters, one representative of each type, the good qualities of both may be utilized. For example, a combination of xanthate and one of the Aerofloat reagents, or of ethyl and amyl xanthate, often effects better metallurgical results than were formerly obtained with a single promoter. This has been called the "dual promoter" system of flotation.

The microscope is becoming an essential tool for the solution of many perplexing flotation problems. Most of the larger operations make periodic microscopic examinations of the various ore feeds and mill products, revealing much more than mere chemical analysis. At the Kimberly mill of the Consolidated Mining & Smelting Company the flotation operators have become so skillful with the microscope that they can determine, quite closely, the zinc content of the mill tailing.

Proper control of hydrogen-ion concentration is an important refinement. The floatability of sulphide minerals is affected by the alkalinity (*pH*) of the pulp, so most operations now determine the *pH* value of their mill circuits frequently.

Each ore has its own peculiarities and is therefore a problem in itself, but results may be classified roughly in groups. Selective flotation of copper-iron and of lead-zinc-iron ores is now common practice all over the world. More recently the selective flotation of copper-zinc-iron ores has been successfully and extensively practiced in Canada and the United States. One property is making a 50 per cent zinc concentrate from a copper-circuit tailing containing less than 1 per cent zinc and over 50 per cent pyrite and pyrrhotite. Were it desirable to do so, this ore could be further dissected and the pyrite and pyrrhotite floated in separate concentrates, delicate separations now possible by the proper use of specific chemicals.

Although flotation is essentially a chemical art, the mechanics of the process are important. Improvements in mechanical equipment have made possible the handling of the enormous tonnages now treated.

Crushing Machinery — Jaw crushers are gradually being replaced by gyratories, some recent installations of which are of enormous size and weight and capable of producing as high as 10,000 tons of 6-in. product per day. Secondary crushing has been revolutionized by the introduction of the cone crusher. This machine, when used with vibrating screens, has a much higher capacity than rolls of the same cost and can effect ratios of reduction heretofore impossible in one stage. Besides having a high capacity and a relatively low power consumption, this crusher permits a fine control of its product, giving a more uniform and desirable ball-mill feed. Many plants have substituted a cone crusher for two or three stages of rolls.

Fine Grinding and Classification — Among the more important developments are: (*a*) the introduction of larger ball and rod mills; (*b*) the increased use of the bowl type classifier; (*c*) more multiple-stage grinding.

A general tendency toward ball mills of larger diameter exists. Also improvements have been made in the internal construction of the mills, including the liners, to obtain a more violent ball action. Recent experimental work in some of the large Western copper concentrators has shown the advantage of multiple-stage grinding and the use of bowl classifiers in the final grinding stage, to effect selective grinding of the sulphides. Practically all millmen now agree that high circulating loads make a more efficient fine-grinding circuit.

Flotation Machines — Developments in flotation machines have been rapid in the last two or three years. The old type Callow and M. S. Standard machines, so popular in the larger mills a few years ago, have been gradually replaced. A detailed metallurgical comparison of the various machines of the new type is not available, but the subaërated mechanically agitated machine seems better adapted than other types for selective flotation. On the other hand, the free-air machines are favored by the large-scale, low-cost operations such as the porphyry copper plants in the Southwest.

During the last year Miami completed the installation of six 100-ft. Miami-Dunn machines. These are, I believe, the largest in the world, having a normal capacity of 3,000 tons and a peak capacity of 4,000 tons per 24 hours. The air is introduced through triangular air chambers on each side. From these chambers the air passes into the ma-

chine through two horizontal slits provided with rubber flaps to prevent the pulp from flowing into the air chambers. Each of the 100-ft. machines requires about 3,000 cu.ft. of air per minute at 1½ lb. pressure.

A modified Southwestern type of machine has been recently developed by the St. Joseph Lead Company. This has 16-in. headers and 3-in. drop pipes. Air, at 1-lb. pressure, is provided by individual centrifugal blowers attached directly to one end of the header of the machine.

In the Geco (MacIntosh type) pneumatic machine a rotor cover has been devised of pure gum rubber, with 225 perforations per square inch. It is claimed that these rotor covers are not affected by highly alkaline circuits, are without tendency to blind, and that the air requirements are one-fourth less than with canvas covers. Many of these rotor covers have been in operation for over a year without visible deterioration.

The mechanically agitated machines have not been neglected, recent developments including the Denver Sub-A (Fahrenwald) machine, the Ruth "Concurrent" machine, and the Kraut. The Denver Sub-A machine has attained great popularity. Certain features of design enable it to handle an unusually coarse feed, as coarse as 10 mesh in the Michigan copper country. In spite of these newer developments, the M. S. Sub-A machine is still in wide use and is doing excellent work.

Steel is fast replacing wood for building practically all types of flotation machines. Almost all mechanically agitated machines are now equipped with individual motors and Tex-rope drives in place of the old gear head-motions, resulting in a decided saving in maintenance and repair, as well as a slight saving in power.

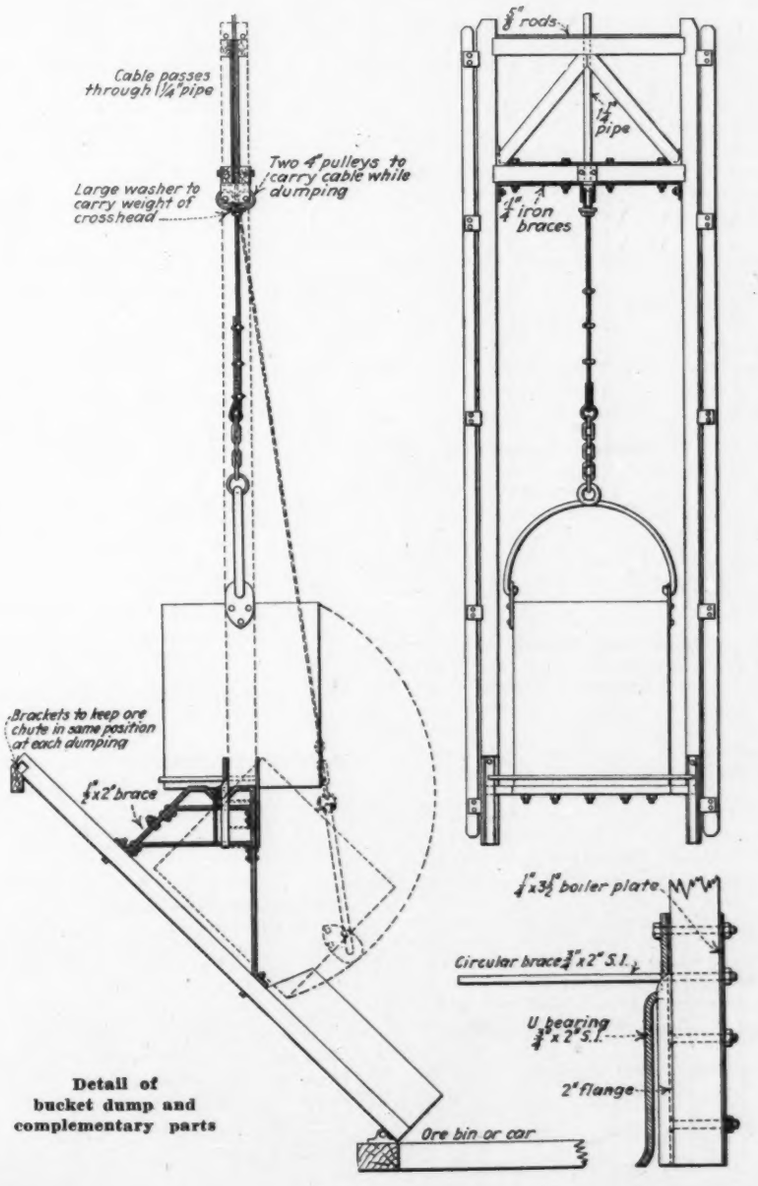
Traction Thickeners — In 1928 the largest traction thickener ever built was put into operation at Miami. This thickener is 325 ft. in diameter and has a settling area of approximately two acres. The entire mill tailing (18,000 tons per day) is dewatered in this thickener, reclaiming approximately 2,000 g.p.m. of clear water for re-use in the mill.

Filters — The introduction of the Dorrco or Shimmin filter marked an important development in continuous filtration. This filter is of the revolving drum type and differs from the ordinary drum or disk filter in that the filter cloth is on the inside of the drum. For this reason the filter seems particularly adapted to the dewatering of coarse, fast-settling material. Within the last year another new type of filter, the Butler, had been put on the market. This filter consists of a number of leaves attached to a traveling belt. It is claimed, also, to be particularly suitable for the filtration of fast-settling material.

Bucket Dump of Novel Construction

THE bucket dump shown in the accompanying illustration was developed by W. J. Loring, general manager of Hammon Copper at Kirkland, Ariz., where a 1-ton bucket has been in continuous use since June, 1928. Larger buckets may be used if desired, in vertical as well as in inclined shafts. No repairs have been necessary since the bucket was installed, and no extra labor is required, as the operation is controlled by the hoistman. It has all the advantages of the old crosshead unit, allowing free passage of the bucket should the crosshead become lodged in the shaft.

A U-bearing and a flange hold the bucket in a rigid position, keeping it from swinging and turning in the shaft, thus making the hoisting of men safer. Passage of air from the shaft is not prevented, a common fault of most dumps, and the bucket is almost as steady in the shaft as a skip running on guides. Perfect safety in dumping is provided, as the door to which the dumping irons are attached serves as a chute for the dumped material. The axle, of 2-in. iron, is bolted to the bottom of the bucket 4 in. from the center line. In the illustration the bucket is shown landed in the chairs; a dotted outline indicates its position during dumping. After being dumped, the bucket is raised to clear the door, which is brought into a vertical position either by an air cylinder or a rope operated by the hoistman.


Cable passes through 1¼" pipe
Large washer to carry weight of crosshead
Two 4" pulleys to carry cable while dumping
⅝" rods
1¼" pipe
1" x ¼" iron braces
Brackets to keep ore chute in same position at each dumping
¾"x2" brace
¼"x3½" boiler plate
Circular brace ¾"x2" S.I.
U bearing ¾" x 2" S.I.
2" flange
Ore bin or car

Detail of bucket dump and complementary parts

Digest of Current Technical Literature

Selected from abstracts of articles in the leading technical periodicals, prepared by Engineering Index Service, American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.

Feldspar Grinding Mills—"Colorado Feldspar Grinding Plant," J. C. Coyle. *Rock Products,* Vol. 33, No. 25, Dec. 6, 1930.

EQUIPMENT and operation Western Feldspar Milling, Denver, Colo.—E.I.S. New York.

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Mixers—"Stirring and Mixing of Sludge." A. Vogt. *Zement,* Vol. 19, No. 34, Aug. 21, 1930.

COMPRESSED-AIR mixer of simple structural design and extremely low operating costs is described.—E.I.S. New York.

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Tin Dredging: Malaya—"Cost of Tin Winning by Dredges." *Min. Jl.,* Vol. 171, No. 4965, Oct. 18, 1930.

BRIEF analyses of accounts of eighteen Malayan companies are presented; costs range from 4.13 to 27.84d. per cubic yard. —E.I.S. New York.

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Mine Hoists: Electric—"Installation of Electric Mine Hoist in Truda Salt Mines." A. Dascalescu. *Annales des Mines de Roumanie,* Vol. 13, No. 11, Nov., 1930.

ELECTRIC auxiliary equipment of hoist. Ward Leonard connection; three-phase induction motor brakes; protective equipment. —E.I.S. New York.

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Quarries and Quarrying: Dust Collectors—"Profits Accruing From Dust Control in the Pit and Quarry Industries." E. H. de Coningh. *Pit and Quarry,* Vol. 21 ,No. 5, Dec. 3, 1930.

EXAMPLES of conditions before and after installation of dust-collecting equipment.—E.I.S. New York.

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Mines and Mining: Dewatering—"The Dewatering of Shafts and Workings." A. L. Egan. *S. African Min. and Eng. Jl.,* Vol. 41, Part 2, No. 2036, Oct. 4, 1930.

MATHEMATICAL analysis of time required for bailing with available hoisting equipment.—E.I.S. New York.

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Copper Mines and Mining: Compressed Air—"Compressed Air an Essential Aid to Successful Mining." J. H. Cooper. *Compressed Air Mag.,* Vol. 35, No. 11, Nov. 1930,

ACCOUNT of large-scale operations of Walker copper mine, in California.—E.I.S. New York.

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Mine Hoists—"Mechanical Handling and Mining Operations." F. J. Garland. *Mech. Handling,* Vol. 17, No. 12, Dec. 1930.

BRIEF description of hoist with two-cylinder conical drum 26 ft. and 14 ft. diam., coupled to gear wheel and pinions driven by two 1,200-hp. d.c. motors at 350 r.p.m. Horsepower varies between 300 to about 4,000 when hoisting coal.—E.I.S. New York.

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Measuring Instruments—"Methods of Measuring Tapered Bores." *Machy.,* Vol. 37, No. 947, Dec. 4, 1930.

ANALYSIS of methods of measuring diameters of tapered holes, both in duplicating and in originating tapered bore; sketches illustrate use of balls in measuring taper bores and use of inside micrometer and guide.—E.I.S. New York.

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Zinc Mines and Mining: Algeria—"Zinc Mining Corporation of Guergour." *Revue de l'Industrie Minérale,* No. 239, Dec. 1, 1930.

SOCIÉTÉ des Mines de Zinc de Guergour was formed in 1906 for exploitation of several groups of deposits in Province of Constantine in Algeria and iron-ore deposit in Djebel-Anini; organization and concessions; geographical conditions; treatment of ore; washing; calcination; power equipment; transportation. — E.I.S. New York.

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Mines and Mining: Recording Instruments—"Recording Appliances in Mining." J. Moeller. *Internationale Bergwirtschaft und Bergtechnik,* Vol. 23, No. 21, Nov. 15, 1930.

USE OF recording meters in mining is discussed, and several instruments for recording electrical values, and pressures, volume, and temperature of water, steam, air, and gas are described.—E.I.S. New York.

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Iron Mines and Mining: Algeria—"Machine Mining of Quenza Ores and Handling of Ores at Port of Embarkation at Bone." P. Vidalenche. *Revue de l'Industrie Minérale,* No. 237, Nov. 1, 1930.

MINING operations were begun in 1922 with manual labor; mechanization fully completed in 1930; details of equipmment installed; mining and haulage equipment; transport of ore to treatment plant; ore-handling equipment at port of Bone.—E.I.S. New York.

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Aerial Transportation in Mining Industry: South Africa—"The Aeroplane in South African Mining." *S. African Min. and Eng. Jl.,* Vol. 41, Part 2, No. 2038, Oct. 18, 1930.

ADVANTAGES to gold, asbestos, copper, and diamond mines; example of use by consulting mining engineer; Southwest Africa and Northern Rhodesia brought nearer; lessons from Europe, Canada, and Australia.—E.I.S. New York.

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Magnesite: Germany—"Silesian Magnesite." A. Reimers. *Keramos,* Vol. 9, No. 23, Nov. 19, 1930.

NOTES on deposits, milling, and uses of magnesite.—E.I.S. New York.

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Air Separators—"Studies of Operation and Efficiency of Air Separators." P. Rosin and E. Rammler. *Zement,* Vol. 19, Nos. 42-45, Oct. 16, 23, 30, Nov. 6, 1930.

RESULTS of tests explain reciprocal action of grinding and separating; tests were carried out at experimental pulverized-coal plant of Saxonian State Metallurgical Works in Halzbrücke on Pfeiffer type of air separator, equipped with triple-roll ring mill of Rema system; efficiency of air separator.—E.I.S. New York.

Electric Locomotives: Mine—"The Rebirth of the Storage Battery Locomotive." T. F. Whalen. *Coal Min.,* Vol. 7, No. 10, Oct. 1930.

REASONS why this type failed to give service anticipated; advantages; safety features.—E.I.S. New York.

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Ore Deposits: Sweden—"Boliden's Ore Deposits." O. Falkman. *Teknisk Tidskrift,* Vol. 60, No. 45, Nov. 8, 1930.

DISCOVERY of deposits containing 2¼ per cent copper, 10 per cent arsenic; 70 grams silver, and 17 grams gold per ton; preliminary work and planning of operation; construction of housing facilities for 500 workers.—E.I.S. New York.

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Sand: Moisture Determination—"Study of Methods for Determining Moisture in Sand." S. H. Graf and R. H. Johnson. *Am. Soc. Testing Matls.—Proc.,* Vol. 30, Part 1, June, 1930.

DATA regarding methods for determining moisture in sands, apparent advantages and disadvantages of different methods and of some suggested modifications; conclusions indicating comparative accuracy, simplicity of operation, and amount of apparatus needed.—E.I.S. New York.

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Mines and Mining: Scraper Loading—"Haulage and Loading by Means of Scrapers." P. E. Leroux. *Revue de l'Industrie Minérale,* No. 238, Nov. 15, 1930.

ECONOMICAL use of scrapers in mines and their advantages; their use in France, and examples of their use in America.—E.I.S. New York.

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Clay Mines and Mining: Excavators—"Small Excavators in Clay Industry." I. Winkel. *Tonindustrie-Zeitung,* Vol. 54, No. 97, Dec. 4, 1930.

DEEP excavator described, similar to chain-bucket excavator, but instead of eight to ten buckets attached to chain on right and left sides, only one bucket, or in the case of larger machines, two buckets, required.—E.I.S. New York.

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Mine-Timber Preservation—"News in Field of Impregnation of Mine Timber." W. Engels. *Internationale Bergwirtschaft und Bergtechnik,* Vol. 23, No. 21, Nov. 15, 1930.

WOOD and its substitutes in mining industry; increased use of impregnated mine timber; tests prove that new timber preservative Fluralsil is high-grade preservative; peculiar action of Fluralsil on wood facilitates application of economical processes by means of salts, reducing impregnation cost about 40 per cent. Drying unnecessary, timber may be used immediately after impregnation.—E.I.S. New York.

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Gold Mines and Mining: Placer—"A Plea for Alluvial Gold Mining." F. H. Williams. *Min. Jl.* Vol. 170, Nos. 4962, 4963, and 4964, Sept. 27, Oct. 4 and 11, 1930.

DESIRABILITY of increasing gold production; lode gold mining now at peak; alluvial gold rushes have led to rapid development of

countries; many known placer fields still exist; important points in prospecting and examination of areas. Gold dredging; working costs; bulk treatment of alluvials; dredging working costs; dredgable areas numerous; saving and treatment of gold concentrates; outlet for dormant British capital is foreseen.—E.I.S. New York.

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Molybdenum—"Molybdenum and Its Engineering Applications." S. L. Malowan. *Chemiker-Zeitung,* Vol. 54, No. 93, Nov. 19, 1930.

LOCATION of molybdenum deposits; methods of extraction from ore; production of pure molybdenum; molybdenum is used metallurgically only in combination with iron or calcium; uses of molybdenum steel. —E.I.S. New York.

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Mine Hoists: Headframes—"New Headframe Design." Schmitz. *Stahlbau,* Vol. 3, No. 19, Sept. 19, 1930.

STUDY of effect which movement of backstay footings may have on static condition of guide posts; design of rocking guide posts with framed backstays.—E.I.S. New York.

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Mine Ventilation—"Comparative Temperatures With Varying Air Movements Underground." E. C. Ranson. *Chem., Met. and Min. Soc. S. Africa—Jl.,* Vol. 31, No. 3, Sept. 1930.

RESULTS showing relative behavior of air at main intakes, splits, working stopes, and drive ends of system.—E.I.S. New York.

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Copper Ore Treatment: Flotation—"The Flotation of Chalcopyrite in Sea Water." A. K. Burn. *Instn. Min. and Met.—Bul.,* Nos. 314 and 315, Nov.-Dec., 1930.

PROCESS used at concentrator of Minera de Tocopilla, in northern Chile, where only water used for milling is obtained from Pacific Ocean; notes on mine and ore; flotation section of mill replaced jigs and tables; four air-agitation cells, two rougher cells each 12 ft. long, and two retreatment cells 8 ft. long; equipment, practice, and results; flow sheet; costs.—E.I.S. New York.

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Copper Refining—"Oxidation of Copper in Reverberatory-Furnace Refining and Significance of Oxide Test." P. Siebe. *Metall und Erz,* Vol. 27, No. 21, Nov. 1, 1930.

WITH aid of microscopic observations, it is possible to detect most important impurities in copper during oxidation period and thus to decide upon best refining process; laboratory melts show importance of some further influences for hypereutectoid structure of copper containing copper oxide.—E.I.S. New York.

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Conveyors: Belt—"Modern Tendencies in Mechanical Handling Plant." L. F. Villiers. *Eng. and Boiler House Rev.,* Vol. 44, No. 6, Dec. 1930.

ADVANTAGES of belt conveyors; description of four different types.—E.I.S. New York.

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Mines and Mining: Rock Pressure—"Calculation of Rock Pressure." G. Grigercik. *Montanistische Rundschau,* Vol. 22, No. 23, Dec. 1, 1930.

ROOF pressure in infinitely narrow horizontal cross-sections; formulas are derived for simple calculation of rock pressure; horizontal sections with rectangular and trapezoidal cross-sections; arched sections; influence of adjacent pits and pressure.—E.I.S. New York.

Granular Materials: Drying—"The Heating and Drying of Granular Materials by Convection." W. Gilbert. *Engineer,* Vol. 150, No. 3909, Dec. 12, 1930.

CALCULATIONS relating to thick-layer dryers with continuous feed; single-shell rotary dryer; effect of grade size; proportion of grades in bituminous coal; effect of casing dryer shell in brickwork; heat transmission in rotary cement kilns.—E.I.S. New York.

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Asbestos Deposits: South Africa:—"The Asbestos Deposits of South Africa." R. Stappenbeck. *Zeit. fuer praktische Geologie (Halle),* Vol. 38, No. 10, Oct. 1930.

CLASSIFICATION of asbestos ores and their occurrence in South Africa; origin and geology of deposits; engineering and economic aspects of mining. Bibliography.—E.I.S. New York.

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Minerals: Specific Gravity—"A Mineral Specific Gravity Chart." K. K. Landes. *Am. Mineralogist,* Vol. 15, No. 11, Nov. 1930.

CHART gives ranges of specific gravity determined for all common minerals; designed to be used primarily in mineral identification.—E.I.S. New York.

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Mines and Mining: Electric Power — "Applications to Mining Work; Annual Report of the Committee on Applications to Mining Work." *Am. Inst. Elec. Engrs.—Trans.,* Vol. 49, No. 4, Oct. 1930.

APPLICATION of electric-power drive in mining to pumps; motor-generator sets; shovels; slushers; mining machines; loading machines; notes on welding; safety work.—E.I.S. New York.

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Mines and Mining: Water Hazards—"A Device for Controlling Mine Dams." G. Trestrail. *Instn. Min. and Met.—Bul.,* No. 315, Dec. 1930.

IN CONNECTION with pumping installation at Settlingstones mines, Northumberland, arrangement for synchronizing water discharge from dam with capacity of pump was devised to prevent flooding of pump.—E.I.S. New York.

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Emerald Mines and Mining: South Africa — "The Emerald Industry of the Transvaal." *Min. and Indus. Mag. S. Africa,* Vol. 11, No. 4, Oct. 15, 1930.

EFFECT of restricted market on producers; low working costs and good quality of stones insure continued production; method of working deposits.—E.I.S. New York.

●

Mine Ventilation—"The Reconditioning of Mine Air." A. L. Egan. *S. African Min. and Eng. Jl.,* Vol. 41, No. 2031-33 Aug. 30 and Sept. 6 and 13, 1930.

REMOVING moisture and cooling air; mechanical process; physical features; factors influencing design; low-compression type of machine chosen. Most suitable size of units; theory of design; three cases considered. Mathematical discussion of low-compression dehumidifying machine in which minimum compression pressure for non-freezing dehumidifying cycle is calculated.—E.I.S. New York.

●

Copper Deposits: Germany—"The Copper-Shale of Mansfeld." J. W. Gregory. *Instn. Min. and Met.—Bul.,* No. 315, 1930.

MANSFELD mining field; theories of origin of ore; Ruecken or small fault-scraps; permian eruptives and source of copper; age of Ruecken; restriction of ore to one horizon; microscopic structure of ore; accessory metals; evidence of accessory metals as to source of copper; formation of copper-shale; lagoonal origin of copper-shale; per-shale; lagoonal origin of copper-shale; raphy.—E.I.S. New York.

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Mines and Mining: Equipment, Steel—"Use of Steel in Mining." R. Wuerker. *Montanistische Rundschau,* Vol. 22, No. 24, Dec. 16, 1930.

SCHWARTZ system of circular underground roadways, employing rolled steel; Leput and Queens systems of roadway, and steel employed.—E.I.S. New York.

●

Feldspar Mines and Mining: Quebec—"Canadian Feldspar Plant Supplies Raw Material to Ceramic Industries." *Pit and Quarry,* Vol. 21, No. 6, Dec. 17, 1930.

RICH deposit in Buckingham district of Quebec now mined by underground method by Feldspar Quarries, Ltd.; furnishes part of spar for new processing plant owned by Canadian Flint & Spar Company at Buckingham; greater part of output is exported to mills at Rochester, N. Y., operated by Consolidated Feldspar Corporation; equipment and operation of mines.—E.I.S. New York.

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Copper Deposits: Africa—"The Correlation of the Ore-Bearing Sediments of the Katanga and Rhodesian Copper Belt." A. Gray. *Economic Geology,* Vol. 25, No. 8, Dec. 1930.

PRINCIPAL copper deposits of Katanga and Rhodesia occur in lower series of System of Katanga, known locally by various names; for simplification Series des Mines is adopted and applied to these rocks over entire copper belt; sulphide orebodies of Rhodesia are found near base, stratigraphically below oxidized ores of Katanga, which are found in dolomites of upper Roan group, and in M'Washia. Bibliography.—E.I.S. New York.

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Ore Treatment—"Sizing by Elutriation of Fine Ore-Dressing Products." A. M. Gaudin, J. O. Groh, and H. B. Henderson. *Indus. and Eng. Chem.,* Vol. 22, No. 12, Dec. 1930.

POSSIBILITIES and limitations of sedimentation and elutriation as applied to sizing of finely ground ore products have been experimentally investigated; this study has led to design of new elutriator and to refinement of usual methods of sizing by sedimentation. Practical value of acetone as settling medium has been demonstrated; microscopic inspection and measurement indicate accuracy of sizing obtained. Bibliography.—E.I.S. New York.

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Copper Mines and Mining: Quebec—"The Aldermac Mine, Rouyn, Quebec." W. P. Alderson and A. A. MacKay. *Can. Min. Jl.,* Vol. 51, No. 50, Dec. 12, 1930.

COPPER, sulphur, and iron to be produced from ore of mine located in Boischatel Township, Temiskaming County, Quebec, on Nipissing Central Railway, 49 miles east of Swastika, Ont., and 10 miles west of Noranda, Que.; geology; type of orebodies; grade and dimensions of orebodies; tonnage; dependable source of Canadian sulphur; Freeman pyrite burner; results from burner; high-grade iron ore byproduct.—E.I.S. New York.

PATENTS

Classifier. No. 1,787,759. Jan. 6, 1930. O. C. Patton and J. G. Rawlins, Denver, Colo.

Design for a pneumatic separator.

Tin. No. 1,786,386. Dec. 23, 1930. E. A. Ashcroft, Ashburton, England.

Process for reducing tin by means of carbon and finely divided iron.

Drill Sharpener. No. 1,788,682. Jan. 13, 1931. C. W. Mitchell, Morenci, Ariz.

Design for a gaging block for a drill-bit sharpening machine.

Mine Car. No. 1,785,433. Dec. 16, 1930. J. J. Body and R. A. Body, Dante, Va.

Design for a dump-registering device on a mine car.

Screen. No. 1,787,852. Jan. 6, 1930. G. W. Behnke and L. E. Soldan, assignors to Simplicity Engineering Company, Durand, Mich.

Design for a vibrating screen.

Leaching Vat. No. 1,783,591. Dec. 2, 1930. A. B. Stevens, Inspiration, Ariz.

Design for a leaching vat with false bottom and a mixing chamber with provisions for agitating the liquor by a gas.

Roasting Process. No. 1,788,767. Jan. 13, 1930. H. Klencke, Frankfort on the Main, Germany.

Design for a multiple-hearth, mechanically-rabbled roasting furnace.

Electrolytic Cell. No. 1,788,512. Jan. 13, 1931. P. Fireman, assignor to Magnetic Pigment Company, New York, N. Y.

Design for an electrolytic cell.

Flotation. No. 1,788,331. Jan. 6, 1930. W. Schäfer, Bochum, Germany.

A step in the froth-flotation process consisting in treating the ore with a solution containing a stable metal salt of a polythionic acid of the formula $H_2S_xO_6$.

Gyratory Crusher. No. 1,780,459. Nov. 4, 1930. R. Bernhard, assignor to Traylor Engineering & Manufacturing Company, Allentown, Pa.

Design for a lubricating system for a gyratory crusher.

Fluorspar. No. 1,785,992. Dec. 23, 1930. J. C. Williams, and O. W. Greeman, assignors to Aluminum Company of America, Pittsburgh, Pa.

A flotation process for concentration of fluorspar.

Flotation. No. 1,780,000. Oct. 28, 1930. E. K. Bolton, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.

Use of mercapto-thiazole as a frothing agent.

Recovering Cyanide. No. 1,787,033. Dec. 30, 1930. R. B. Bryan, assignor to The Merrill Company, San Francisco, Calif.

Cyanide is recovered from a cyanide solution by acidifying the solution to form hydrocyanic acid, passing a current of air through the acidified solution, treating the air current by brief contact with an alkaline solution to remove foreign acid constituents without appreciable neutralization of the hydrocyanic acid, and finally subjecting the air to long, intimate contact with an alkaline solution to absorb the hydrocyanic acid.

Flotation Reagent. No. 1,785,742. Dec. 23, 1930. S. P. Miller, assignor to Barrett Company, New York, N. Y.

Flotation reagent, consisting of a mother liquor containing alpha-naphthylamine and other constituents of crude alpha-naphthylamine.

Zinc Metallurgy. No. 1,778,987. Oct. 21, 1930. R. H. Stevens, G. C. Norris, W. N. Watson, assignors to Rhodesia Broken Hill Development, Broken Hill, Rhodesia.

Process of purifying zinc sulphate solution.

Mine Car. No. 1,784,477. Dec. 9, 1930. L. Almquist, assignor to American Car & Foundry Company, New York, N. Y.

Design for a mine car with a drop door pivotally mounted.

Flotation. No. 1,783,206-07. Dec. 2, 1930. G. H. Wigton, Eureka, Utah.

Application of the reaction product of phosphorus pentasulphide and an alcoholic solution of alpha naphthylamine or an oxygen-free aromatic amino compound as frothing agents.

Grinding Mill. No. 1,783,358, Dec. 2, 1930. J. Crites and W. A. Koren, assignors to Raymond Brothers Company, Chicago, Ill.

Design for an automatic temperature control in grinding mills.

Crusher. No. 1,783,373. Dec. 2, 1930. G. W. Borton, assignor to Pennsylvania Crusher Company, New York, N. Y.

Combination of a single-roll crusher with a toothed crushing roll and a breaker plate made of interchangeable sections, individually adjustable.

Electrical Precipitation. No. 1,787,955. Jan. 6, 1930. C. Z. Rosecrans, assignor to Leeds & Northrup, Philadelphia, Pa.

An electric precipitator, consisting of a tube of semi-conductive material with a conductive coating on the exterior, and a wire electrode.

Refractory Lining. No. 1,789,131. Jan. 13, 1930. R. C. Benner and G. J. Easter, assignors to The Carborundum Company, Niagara Falls, N. Y.

A furnace lining consisting of refractory blocks which have been pressed in a direction perpendicular to the plane of the exposed faces of the blocks.

Reagent Feeder. No. 1,787,289. Dec. 30, 1930. G. G. Thomas, assignor to American Cyanamid Company, New York, N. Y.

A method of feeding a reagent by intermittent delivery of the reagent to a mixing tank, where a constant supply of a liquid is added, overflowing the mixture continuously from this tank.

Mine Car. No. 1,784,472. Dec. 9, 1930. V. Willoughby, assignor to American Car & Foundry Company, New York, N. Y.

Design for a mine car with vertical webs and projecting flanges to which the floor is secured.

Thorium Metallurgy. No. 1,787,672. Jan. 6, 1930. E. S. Davenport, assignor to Westinghouse Lamp Company, Bloomfield, N. J.

Metallic thorium is rendered resistant to atmospheric corrosion by anodic treatment in a bath of glacial acetic acid containing an ionizable constituent capable of yielding oxygen at the anode.

Flotation. No. 1,784,280. Dec. 9, 1930. L. W. Ferris, Salt Lake City, Utah.

Flotation of copper-silicate minerals is accomplished by subjecting the minerals to a heat-treatment and treating the decomposed mineral by a flotation process.

Antimony. No. 1,786,908. Dec. 30, 1930. A. Hanak, Philadelphia, Pa.

Process for separating antimony from lead alloys by treating the alloy with an alkali metal to form a less fusible antimony-alkali alloy, which is dissolved in molten caustic alkali. The caustic melt is dissolved in water, whereby antimony is separated in the metallic state.

Flotation. No. 1,787,938. Jan. 6, 1930. J. Eisele, R. Griessbach, and C. Heuck, assignors to I. G. Farbenindustrie, Frankfort on the Main, Germany.

A flotation process using a frother made by oxidizing hydrocarbons of high molecular weight at an elevated temperature, not exceeding 200 deg. C.

Mine Car. No. 1,784,473. Dec. 9, 1930. V. Willoughby, assignor to American Car & Foundry Company, New York, N. Y.

Design for a mine car with drop doors with latches mounted on an axle.

Ore Reduction. No. 1,785,428. Dec. 16, 1930. W. H. Smith, Detroit, Mich.

Heavy hydrocarbons are added to a metallic oxide and the charge is fed continuously through a zone of fixed temperature sufficient to crack the hydrocarbon and reducing the ore. The cracked hydrocarbons are removed and the reduction of the ore is completed by another reducing agent present in the charge.

Rock Drill. No. 1,789,117. Jan. 13, 1931. W. A. Smith, Jr., assignor to Ingersoll-Rand Company, Jersey City, N. J.

Design for a valve for rock drills.

Rock Drill. No. 1,789,118. Jan. 13, 1931. W. A. Smith, assignor to Ingersoll-Rand Company, Jersey City, N. J.

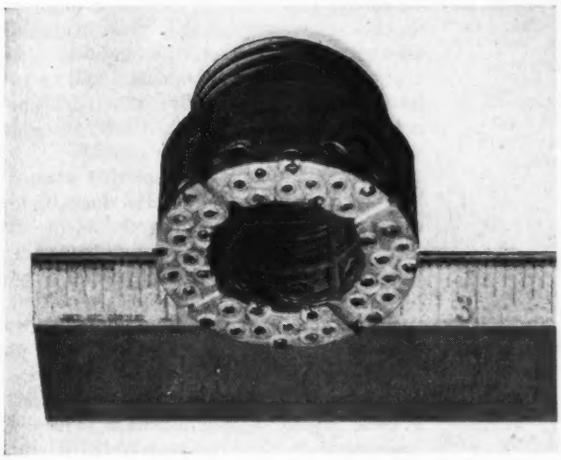
Device for oiling a rock-drill mechanism.

Rock Drill. No. 1,788,972. Jan. 13, 1931. L. C. Bayles, assignor to Ingersoll-Rand Company, Jersey City, N. J.

Design for a chuck bushing for rock drills.

INDUSTRIAL PROGRESS

African Bort Attains Increasing Use in Diamond Drilling



Crown of diamond drill set with fifty-six "Finehards"

J. Hanifen

Los Angeles office
The Van Itallie Company

SOUTH AFRICA has in recent years achieved unique distinction in the age-old industry of mining. Within the memory of men and women of the present generation that country has assumed definite leadership in the production of gold and of diamonds. The world's major sources of its most valuable mineral products are thus brought in increasing measure under a control that renders them susceptible of a high degree of scientific development, management, and marketing.

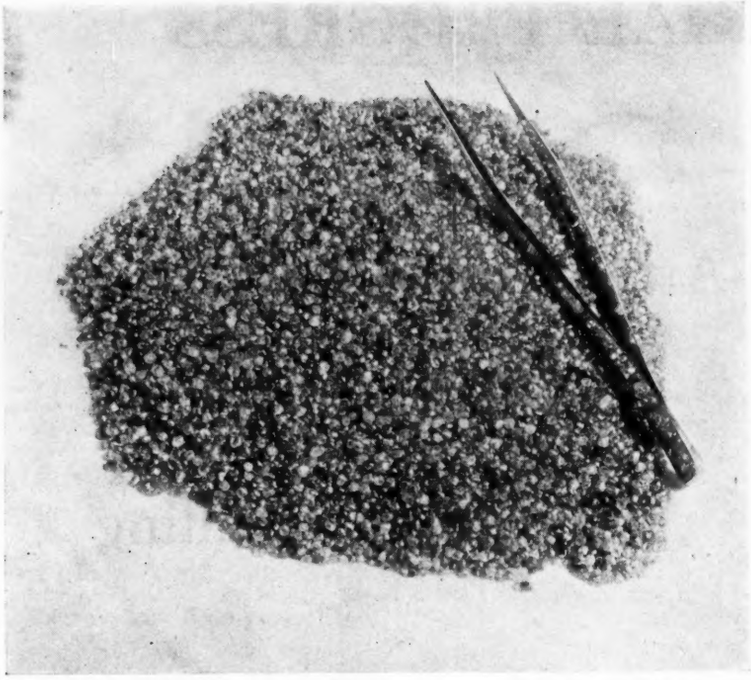
Of gold, civilization and industry will probably never experience a surfeit, but unregulated production and highly competitive marketing of diamonds used for drilling might within a few years destroy an industry important to the production of all other minerals and metals.

For considerably more than half a century the use of the diamond drill in prospecting for metals has been recognized as indispensable to accurate and trustworthy determination of the characteristics of mineral-bearing strata. In recent years a scarcity in the supply of industrial diamonds seemed destined to increase diamond-drilling costs to a figure that not alone made the usual methods inordinately expensive, but operated, as a complementary development, to slow up the search for gold and also for that increasing supply of metals and minerals essential to the orderly functioning and advance of those industries dependent on the so-called base metals and minerals. The progressively increasing scarcity of industrial diamonds since the ending of the Great War, and throughout the last half decade especially, had the inevitable consequence of developing keen competition among buyers and dealers in such stones.

Early in 1928, Mr. Dorus Van Itallie, of the Van Itallie Company, exclusive United States agents for J. K. Smit & Zonen, of Amsterdam, and the writer, the Van Itallie Company's Western manager, initiated a campaign of research having for its objective the development of a supply of efficient industrial diamonds that should complement and supplement the decreasing importations of carbon and ballas from Brazil, which have long held first rank as efficient media for diamond drilling. Mr. Van Itallie has made available the following résumé of the search for a bort that would stand up under the difficult conditions incident to all diamond-drilling operations:

"Immediately prior to 1928 the diamond-drill industry was believed by many experts to be approaching a critical situation. World demand for diamonds used for drilling was exceeding production. For a brief period surplus stocks held by dealers throughout the world made up the shortage, but such stocks are now largely exhausted. Although metals and alloys have been produced that approximate, in hardness, both carbon and bort, their use has been restricted, in drilling, by the fact that they are not abrasive. After a series of conferences with my business associates, in which an exhaustive study and analysis of the situation was completed, our companies decided to make a survey into the practicability of discovering a diamond, suitable for drill work, among the scores of varieties produced by the great South African diamond mines and marketed directly and scientifically by the Diamond Syndicate, of London, which controls its product in every phase of its progress from the earth to the consumer. Three factors are essential to a diamond drilling medium: toughness, hard crystallization, and, lastly, adequate, assured continuous supply, without which any degree of price stabilization is obviously difficult of attainment.

"A request to the parent firm of J. K. Smit & Zonen, of Amsterdam, resulted in the forwarding to America of a vast assortment of different types of South African diamonds, in size varying from twenty per carat to three carats each. All of these stones were subjected to specific gravity, pressure, and breakage tests. Of the entire shipment, only one lot passed successfully the tests specified. The remainder shattered under pressures or were so soft as to be worthless for drilling. The stones of one parcel that proved acceptable for the purpose which inspired our researches were characterized, when examined microscopically, by unusually hard crystallization. Small stones averaging twelve to the carat were placed between steel plates and pressure up to 2,700 lb. was applied without shattering or breakage. These stones were lustrous in appearance, the colors ranging from a faint to an extremely dark brown. They were true borts. Subsequent shipments, which



A pile of hard, crystalline South African bort, especially selected and graded for drilling purposes

had been subjected to highly selective tests before importation, were proved to possess a high standard of size uniformity and hardness. The stones, as graded, are almost uniform in dimension and weight, according to carat specifications, varying from round and round triangle to octahedrons. In fact, a lot of some thousands of carats when spread out on a tray or tablet, resembled, because of their uniformity, a mass of barley grain, or rye, or wheat. Selected stones are as alike as peas in a pod. Because of the unique characteristics of these selected borts, the Van Itallie company named them 'Finehards,' as a trade and business designation, and they are so officially registered.

"'Finehards' average from a third to a twentieth of a carat in size. Initial missionary work incident to their introduction involved overcoming a traditional preference on the part of dealers for larger stones, bort and other. Practical and severe field tests, however, demonstrated that the use of the small, selected, hard African bort possessed distinct technical advantages. By the use of small stones, a greater number of cutting points could be set into a bit. In fact, the number of cutting points was limited only by the number of stones that may be set and held securely in the metal crown. Even the early tests, with the small borts set in every conceivable manner, and subjected to a wide variety of drilling conditions, from talc to chert, proved the stones to be exceptionally efficient for diamond-drill work. Equally important, capital outlay for both the diamonds themselves and for drill bits fully equipped was materially reduced. The total cost for equipping an ES bit with a drilling face and sides is usually below $100. Furthermore, the burning and breaking hazard is lessened.

"Reports from the company's field representatives have developed the further interesting fact that the use of small uniform borts cuts fuel consumption on steam- and gas-driven rigs, and that many small stones set into a bit assure operation with a minimum of vibration, which is a serious factor in wear of parts and of machines, and the avoidance of which assures a greater drilling speed and smoother functioning.

"The uniformity in sizes made available by close-grading South African bort has proved to be of marked advantage in the work of setting diamonds in the crown or shoe of the drilling bit, and the use of ordinary tools and drills has made practicable a high degree of standardization, and hence a marked economy in time and labor in equipping bits for work. Uniform shapes simplify greatly the technique of placing the stones in the crown.

"The use of the new product has advanced definitely beyond the experimental stage. 'Finehards' are attaining approved acceptation throughout the United States and Canada, and preliminary steps toward introducing them into technical practice in all foreign mining fields are well advanced."

Consideration of the fact that nature has vouchsafed to man only one single crop and supply of diamonds, as of all other minerals and metals, indicates the imperative necessity, and the social duty, of so adapting industrial operations that the tool that is scientifically and technically applicable will be confined to those uses which cannot be otherwise served as efficiently. A technically critical degree of specialization is herein indicated to be indispensable if the ultimate of benefit is to be derived from our natural resources. The competent mining engineer of the years ahead will be called upon to exercise a highly critical discriminatory faculty in his selection of drilling media. He will unquestionably reserve both carbon and bort for those many uses which no steel yet fabricated has been able to meet: for drilling through rocks that only the diamond can wear away and penetrate.

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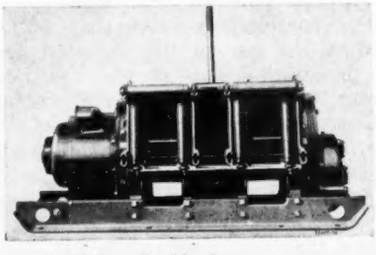
New Slusher Hoist Fully Inclosed —A Novel Single-Roll Crusher

Other Equipment

MINING and metallurgical equipment recently introduced includes the following:

A 15-hp., double-drum, electric hoist of interesting design for scraping and dragline work has been developed by the Ingersoll-Rand Company, New York. It may be used with either a.c. or d.c. motors, develops a 2,000-lb. rope pull at 240 ft. per minute, and will take 300 ft. of $\frac{1}{2}$-in. cable on each drum, or 500 ft. of $\frac{3}{8}$-in. cable. All parts are inclosed and rigidly supported by a cylindrical steel housing, insuring perfect alignment. Each drum is driven by a three-shoe internal expanding friction clutch. Only one drum can be engaged at a time. Both clutches are operated by a single lever. Helical stub-tooth gears are used. Cable guide rollers are mounted on Timken bearings. Steel skids are provided.

Design of the Weller capstan car puller has been improved by the Webster & Weller Manufacturing Company,



A 15-hp. double-drum scraper hoist having all parts inclosed and rigidly supported

1856 North Kostner Ave., Chicago. It is electrically operated, and built in three sizes to handle from one to six 80-ton cars. It will pull at any angle.

A Single-Roll Crusher

McLanahan & Stone Corporation, Hollidaysburg, Pa., has developed a so-called sledge-wedge crusher, in which are said to be combined the pounding action of the swing-hammer mill, the squeezing action of the jaw, cone, and gyratory crushers (intensified by use of teeth that force material between the crushing surfaces), and the splitting action of wedges driven through the rock by reduction gears. The crusher has a solid one-piece heavy and sturdy frame, without welded joints, rivets, or bolts. Having few parts, it is simply built. Crushing continuously, it is said to use power with maximum efficiency. It is equipped with the company's patented "steelstrut" toggle, which is said to give control of sizing and protection against tramp iron. The rolls may be be had in designs to suit any product.

Conveying Hot Materials

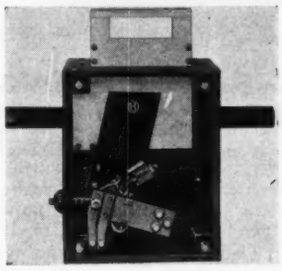
Rights to a rotary tubular conveyor invented by F. C. Jacoby have been secured by the Hardinge Company, York, Pa. This is intended for conveying hot or abrasive materials over long distances with minimum repairs and dust losses. It is a screw-flight conveyor, cast integral with the casing. Sizes range from 7 to 24 in. in diameter, and capacities are from 1 to 100 tons per hour.

Constant-Weight Feeding

A new type of constant-weight feeder has been designed by the Hardinge Company to feed coarse materials at very low or very high capacities; for securing high capacities with all sizes of mixed feed up to 5 in. in diameter; and for feeding moist, sticky materials without clogging. It is more heavily built than the standard Hardinge type and has an extra large bin. It may be had with a dustproof housing and equipped for remote control.

A Time-Limit Circuit Breaker Switch

Ability to sustain a given overload for a definite period of time and complete protection to the machine in the event of a short circuit are combined in a new time-limit circuit-breaker switch developed by the Ohio Brass Company, Mansfield, Ohio. Primarily a circuit breaker, this switch will kick out instantly when a short circuit occurs. However, overloads of a definite value may be sustained for any desirable period of time from a few seconds to 20 minutes by setting the time-element accordingly. Mine locomotives, for instance, may be protected by having the circuit breaker set to throw out just before dangerous overheating of the motors occurs. Thus, full protection from short circuits is always afforded, but starting loads and other temporary excessive demands do not result in the breaker disconnecting. Another extensive use for this switch is that of set-



This circuit-breaker switch will sustain overloads, with protection, for any period desired up to 20 minutes

ting it to sustain an overload for a period just within the time interval of the demand meter, arranging for it to throw out before this demand limit is exceeded. This circuit breaker ranges in capacity from 350 to 1,200 amp. and operates on currents of 250 to 600 volts d.c.

Rotary Drying for Sticky Materials

Hardinge also announces a new Ruggles-Coles rotary dryer for flotation concentrate which tends to ball up or pack in other types of rotary dryers. It has a specially designed feed head to facilitate introducing the sticky wet concentrate and to keep the flame from impinging against the shell. The material is stirred up by flights and baffles as it passes through the drying area and thus will not stick to the shell or ball up. Dust loss is small and thermal efficiency high.

Blast Furnace Blower of Record Size

What is thought to be the largest centrifugal blast furnace blower in the United States was installed recently by the DeLaval Steam Turbine Company, Trenton, N. J., for a steel company.

This is a five-stage centrifugal compressor of the single-suction type, directly coupled to an impulse pressure stage steam turbine, and has a maximum capacity of 115,000 cu.ft. against 30 lb. per square inch gage pressure. The turbine was designed to run at 2,600 r.p.m. on steam at 400 lb. per square inch superheated 200 deg. F., and exhausts to a vacuum of 28 in. The critical speed is considerably above the maximum operating speed.

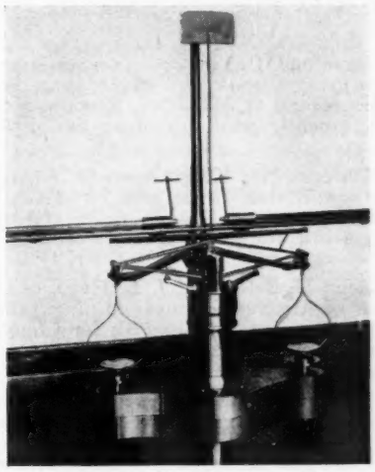
Pipe for Ventilation and Drainage

Successful use of Armco corrugated iron pipe for mine overcasts is claimed by the Armco Culvert Manufacturers' Association, Middletown, Ohio. This new use is said to apply particularly to temporary installations which are to be left in place only until the particular area served has been worked. The pipe can then be transferred elsewhere. The sections are long and of strong, light-weight construction, and develop a high beam strength.

Armco Association also states that its paved invert pipe has been improved by increasing the number of pavements, offering a still greater use for this type of pipe in the drainage of acid mine waters. Originally this pipe had a single asphaltic pavement in the invert of the culvert where the wear of abrasive materials is concentrated. Experience has shown that still greater protection can be secured by increasing the number of pavements. As a result, the pipe is now provided with two or more pavements, depending on the diameter. In tests made to determine the effect of acid mine waters on metal pipe, specimens coated with asphalt have been found to meet the requirements of protection where the coating was heavy enough and remained intact.

A New Assay Balance

An accompanying cut shows a new assay balance recently developed by William Ainsworth & Sons, Inc., Denver, Colo. The beam is of hard-rolled duralumin with agate edges and planes and agate (jewels) contacts throughout. The unit construction with swing-



Improved construction features this assay balance

ing drop levers maintains the alignment of all working parts during transportation and in service and insures rapid operation of the balance without "kick" which is so objectionable in balances of high sensitivity.

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A Handbook on Steel

Users of drill steel will be interested in the new "Hollow Drill Steel Handbook," recently put out by John Bedford & Sons, Ltd., Sheffield, England. This discusses the manufacture of "copper core" hollow steel. The greater part of the book is devoted to a discussion of drill steel in general, its use and treatment.

Personal Notes . . . Comment . . . Criticism

Harold Kingsmill, general manager of Cerro de Pasco, is in New York.

H. W. Hardinge, now in Europe, expects to return to New York late in February.

Dr. L. D. Ricketts, accompanied by Mrs. Ricketts, returned recently from a four-month trip to Europe.

H. C. Goodrich, chief engineer of Utah Copper, has been elected president of the Engineering Council of Utah.

Walter F. Pond, Tennessee State Geologist, has been elected president of the Engineering Association of Nashville for 1931.

Robert E. Cranston recently returned to New York from an extended professional trip to Australia, Tasmania, and New Zealand.

Dr. Victor Dolmage was re-elected president of the British Columbia Chamber of Mines at the recent annual meeting of that body in Vancouver.

J. F. Mitchell Roberts, metallurgical engineer with Oliver United Filters, at San Francisco, has been transferred to the New York office of the company.

Sherwin F. Kelly writes that he will lecture at the Missouri School of Mines on the subject of geophysics, not geology, as erroneously reported in our last issue.

Raymond Guyer, consulting engineer and managing director of Mexican Premier Mines, at Mazatlan, Sinaloa, Mexico, recently paid a visit to San Francisco.

Clarence R. King, research chemist for the United Verde smelter at Clarkdale, Ariz., is in Canada, doing consulting work for Hudson Bay Mining & Smelting.

Reno H. Sales, and **J. L. Head,** of the staff of Anaconda Copper Mining, sailed from New York on Jan. 31, for Chuquicamata, where they will remain for a few weeks.

Frank L. Stack, superintendent of smelting for the Federated Metals Corporation, Newark, N. J., has been appointed general superintendent. **S. Turkus** continues as general manager.

Dr. W. E. Cockfield was recently elected chairman of the mining bureau of Vancouver Board of Trade. He is superintendent of the British Columbia division of the Geological Survey of Canada.

Stewart Carpenter, formerly assistant head of the preparation department of the Copper Queen smelter at Douglas, Ariz., has left for Africa, where he has accepted a position with Roan Antelope Copper Mines, Ltd.

Walfred Been, for the last two years efficiency engineer at the Champion mine of the Copper Range company, at Painesdale, Mich., has accepted a position as safety engineer at the Ahmeek mine of Calumet & Hecla. He has been succeeded at Champion by **Theodore Soder,** a member of the engineering staff. Both men are graduates of the Michigan College of Mining and Technology.

Rafael Mancera, Undersecretary of the Treasury of Mexico, speaking at a recent meeting in New York of the Mexican Chamber of Commerce in the United States, declared that the creation by American business men of a market for Mexican silver would do more to facilitate trade with Mexico and to build larger Mexican and Latin-American markets for goods manufactured in the United States than any other action this country could take at this time. "Silver in Mexico represents more than half the buying power of the republic," said Mr. Mancera. "I cannot too strongly urge that American business men sell their goods against silver in their export trade with Mexico. Manufacturers in your country should be interested in such a program because gold in Mexico represents only about five per cent of her international debts, and if Americans will aid in revaluating silver, greater Mexican markets will be opened for their products."

S. J. Cook, general secretary of the Fifth Pacific Science Congress, writes that arrangements for the next meeting of the congress are well in hand. The meeting will take place in Victoria and Vancouver, British Columbia, in May and June, 1932, and will discuss general scientific problems of international interest pertaining to the welfare and advancement of the peoples of the countries bordering on the Pacific Ocean. It will be the first of the congress meetings to be held on the American side of the ocean. **Dr. Frank D. Adams,** Logan professor of geology, McGill University, is a vice-president of the congress, and **Dean W. R. Brock** of the University of British Columbia, former director of the Geological Survey of Canada, is a member of the executive committee and chairman of the division of physical sciences. **Dr. S. J. Schofield,** professor of physical and structural geology at the University of British Columbia, and a former member of the Canadian Geological Survey, is chairman of the sectional committee on geology and mineral resources.

Prof. J. W. Gregory, in the recent Thomas Hawksley Lecture before the Institution of Mechanical Engineers, declared that the earth may be regarded as a machine, being composed of various parts and moving mechanically as contrasted with a body having consciousness and will. Continuing, he said: "Like any well-regulated machine, it consists of a combination of various parts. It moves through space and rotates on its axis in mechanical obedience to the major forces of the universe. The interaction of the different parts of the earth machine has rendered possible the evolution of man and still controls his destiny, for it keeps the earth's surface drained and habitable; it distributes the sea so that the land is supplied with rain and fresh water; it maintains the constituents of the air at the balance required in the breath of life, and it raises from the interior the minerals that renew the fertility of the soil and provide the mechanical engineer with the materials that have rendered possible the development of modern civilization."

Dr. J. W. Finch, dean of the School of Mines, University of Idaho, in a recent statement to the press, said that potential mining districts exist in Idaho which will remain unknown and undeveloped until a detailed and accurate geological survey is made of the whole state. Extension of the operations of the Idaho Bureau of Mines and Geology, of which he is secretary, with the cooperation of the U. S. Geological Survey, to obtain a full survey of the mineral resources, is Doctor Finch's proposed plan of action. "I believe," he said, "that there is much mineral, particularly gold, in Idaho, never discovered, that could be mined profitably after trained geologists have located orebodies overlooked by the old-time prospectors. To aid in this exploiting we need a complete geological map of the state. Surveys have been made in various sections, but much remains to be done. The survey is only a patchwork affair at present, but when it is complete it will show geologists where to look for ore. It was this type of work that opened up the great copper fields of Rhodesia, Africa. Maps showed the geologists where to drill, and they uncovered great deposits where prospectors had walked for years without making important discoveries. We hope by obtaining a complete survey of the state to open new mining districts in Idaho. Much of the state is mountainous, and it is thus dependent upon some other industry than farming." Opportunities for well-trained young mining engineers exist in spite of the general business depression and curtailing of production in the mining industry, Doctor Finch believes.

OBITUARY

Harold M. Hedin, mine captain of the Puritan mine of Oliver Iron Mining, died recently at Ironwood, Mich., after a short illness.

Frank H. Culbertson, pioneer resident of Idaho, who was active in the development of the Tiger mine, in the Coeur d'Alene district, died in Spokane, Wash., on Dec. 30, two weeks after an operation. He was 72 years of age.

Ray E. Wickham, mining engineer, died in Salt Lake City on Dec. 28. He was a graduate of North Dakota and Columbia universities, and practiced his profession in Idaho for over twenty years. At the time of his death, he was operating a manganese property. Mr. Wickham is survived by his widow and four children.

Dr. Richard B. Moore, first American to isolate radium and helium, died in a New York hospital on Jan. 20. At the time of his death Doctor Moore was dean of science at Purdue University. He was chief chemist of the U. S. Bureau of Mines from 1919 until 1923, leaving to join the staff of The Dorr Company. He left the position of general manager of The Dorr Company to take up his last post at Purdue. Doctor Moore was 59 years of age.

NEWS OF THE INDUSTRY

Potosi Development Continues, But Output Is Not Pushed—Britannia Curtailing

Production is not being pushed at the lead-zinc property of El Potosi Mining, in the Santa Eulalia district, Chihuahua, Mexico, but development work is being continued at the normal rate, despite low metal prices. The physical condition of the mine, which is controlled by Howe Sound, is excellent. Early in 1930, operations were hampered by the lack of power resulting from drought in northern Mexico. Since April, however, the full quota of power has been available and the company has been able to make up for lost time in development work.

At present, three of the El Potosi shafts are being deepened—Nos. 1, 3, and 5 (Santo Domingo). No. 1 shaft is below the No. 19 level; No. 5 shaft is below the No. 18 level; and No. 3 shaft is below the No. 17 level. Levels are being established at intervals of 50 m., or about 165 ft., as compared with the former practice of crosscutting at 100-ft. intervals. Ore extraction and development can be conducted more economically with the greater distance between levels.

Results of work done at depth indicate that the sulphide orebodies, now responsible for the larger part of the company's production, continue to maintain grade and area. In fact, lateral work has not only corroborated but has exceeded the results obtained by diamond drilling. At present, the workings in the area of No. 3 shaft are being pushed east on the No. 14 level in the direction of No. 2 shaft, which is bottomed at the No. 12 level. The company expects to develop this eastern section of the property through No. 16 level as well.

Present production from the Potosi mine is about 45,000 tons of lead-zinc sulphide ore and 3,500 to 4,000 tons of direct-smelting lead carbonate ore monthly. The sulphides are handled in the company's San Guillermo mill, which has been gradually enlarged and at present has an effective capacity of more than 2,000 tons daily, indicating that present milling operations are at 75 per cent of capacity. Slight changes in the flow sheet have effected improvement in the separation of the lead and zinc contents of the ore, with higher recoveries. Carbonate ore is shipped to the Morse smelter of American Smelting & Refining at Chihuahua, 12 miles distant, which also handles the lead concentrate from the mill.

During the last year, additions to equipment have included a new 2,500-cu.ft. unit for the compressor plant, 24 30-ton railroad cars for hauling ore and concentrate on the surface, and 24 4-ton mine cars underground.

At the Britannia property, in British Columbia, Canada, another Howe Sound subsidiary, production has been curtailed because of the present situation of the copper market. Present output is at the rate of about 2,600,000 lb. of copper monthly, compared with an average production of about 3,850,000 lb. monthly up to November, 1930. Development work has been vigorously prosecuted and has added a substantial tonnage to the known ore. However, sufficient work has not yet been done to determine whether continuation of the main haulage, or 4,100 level, to cut the orebodies is justified.

Results of development to date at the recently acquired Chelan Copper property, at Chelan, in central Washington, have been very satisfactory. Development work will be continued throughout 1931. The company has a low-grade copper vein deposit at this property, which it is opening up through tunnels. About 125 men are employed at Chelan. The uncertain metal situation has prevented the company from coming to a decision on construction of a concentrator. Continuation of development, however, is expected to add to the reserves, with the result that when decision is made the company will have more adequate data available on which to base the size of the plant. Concentrate will probably be shipped to Tacoma, Wash., for smelting.

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Treadwell Yukon Ships Its First Bullion From Bodie

The first shipment of gold bullion has been made by Treadwell Yukon from its operations at Bodie, Calif., where it is reopening a large number of old gold properties in the hope of developing a large-scale low-grade producer. The bullion was worth about $11,000, and represents gold recovered from both the low-grade and high-grade units.

A 400-ton flotation mill has been put into operation to treat low-grade surface ore, mined by a power shovel from a block of ground that is to be thoroughly tested as a possible large-scale producer, similar to Alaska Juneau. About 50,000,000 tons will be sampled. Production is also coming from a rehabilitated twenty-stamp amalgamation mill, which is handling high-grade ores from underground. A small tonnage of ore has been blocked out in the Red Cloud shaft.

■

Arizona Accident Statistics

The annual report of the state mine inspector of Arizona shows that 21 fatal accidents occurred in Arizona mines in 1930, compared with 32 accidents in 1929. However, the total number of men employed decreased from 14,429 men on Dec. 31, 1929, to 8,963 men on Dec. 31, 1930. Underground employees numbered 6,475 at the end of 1930, compared with 11,499 the year before; and surface employees were 2,488, compared with 3,030.

Empire-Star Mines Maintain Reserves as Output Rises

Development work has been vigorously pushed at the Empire-Star properties, in the Grass Valley gold district of California. Although no important new deposits have been opened up, the additions to known orebodies have maintained the amount of ore in sight, despite an increase in production. Estimated bullion output for 1930 was $1,653,000, compared with $806,000 in the eight months of 1929 during which Newmont Mining (which now controls the properties) was in possession.

Development has been centered on lateral work, rather than in extensions of the orebodies at depth. During 1930, several months saw more than 2,000 ft. of new drifts and crosscuts driven, with the record footage at about 2,400. In addition, about 4,500 to 5,000 ft. of diamond drilling was done. Newmont has not attempted to deepen the Empire workings, which are still bottomed on the 7,000 level, about 4,000 ft. vertically below the surface, and has only slightly lowered the deepest North Star workings, formerly bottomed at the 8,600 level. The number of leasers at work in the upper levels of the North Star is increasing.

All company ore is being handled in the 80-stamp Empire mill, which has been connected with the North Star mine by a new 6,000-ft. tramway. At the North Star mill, in addition to ore for experimental purposes, the output from the leases is being handled. Flotation equipment, consisting of a six-cell Kraut unit, has been installed there. As much of the lease ore is highly oxidized and cyanide consumption is relatively high, the residue is being treated by flotation. About twenty stamps are in operation at the North Star plant.

■

Report on Alaska Railroad

Fairbanks Exploration, engaged in gold-dredging operations near Fairbanks, Alaska, should not be allowed to mine the property of the government-owned Alaska railroad, according to a report on the present status of the property, presented by a committee of the U. S. Senate. The Fairbanks operations are near the Chatanika Valley branch, which was abandoned three weeks before the committee made its trip to Alaska. The report states that although this branch has been abandoned, the government should seek to hold its property rights in the right-of-way.

In regard to the portions of the railroad still in operation, the committee, composed of Senators Howell, Kendrick, and Thomas, recommend that operation be continued, with the practicing of certain economies. The committee suggests that of the $1,000,000 budgeted in the pending appropriation bill for the railroad, $250,000 be used for investigation of mineral resources by government engineers.

New St. Joe Zinc Plant Put Into Operation

Operation of the acid plant at the new zinc smelter of St. Joseph Lead, at Josephtown, Pa., has been in progress for about three weeks. The first electrothermic furnace was connected to the baghouse and placed in operation on Jan. 12. The smelter has been designed to treat concentrate from the company's mines in St. Lawrence County, N. Y., by an electrothermic process.

The plant, which has a capacity of about 120 tons of concentrate daily, includes a contact sulphuric acid plant, equipped with two twelve-hearth Herreshoff roasters and a complete purification system, using a vanadium mass. Three Dwight & Lloyd sintering machines constitute the sintering plant. The furnace plant is made up of a battery of electrothermic furnaces, so designed that they can be equipped with condensers for the manufacture of slab zinc, or manifolds and ducts to a baghouse for the manufacture of zinc oxide. The current is introduced directly through the charge of sintered ore and coke. Resistance set up by this charge causes the necessary heat for reaction. The plant is equipped with the additional facilities of change house, machine shop, first-aid room, laboratory, and office building.

Considerable work has been done by the company in introducing grades of zinc oxides suitable for use in the rubber industry.

■

Inco Curtails Output Further

A further curtailment of operations of International Nickel, in the Sudbury district of Ontario, has been announced. This includes a 25 per cent reduction in tonnage at Creighton mine, with a corresponding reduction in smelter production at Coniston, where one blast furnace has been closed down. Frood production amounting to some 3,000 tons daily is being maintained, although development work, which had recently been advanced well ahead of mine requirements, has also been curtailed.

Diamond-drill exploration which the company was carrying on at the Murray mine and also at the Frood has been suspended. Matte production will be reduced as a result by approximately one-fourth. At the Ontario Refining Company's plant one furnace is sufficient to handle the blister copper supplied by International Nickel and Granby Consolidated, which to date are the company's only shippers. Reports that present plans include the closing down of the Coniston plant have been denied.

■

Gunsight Starts Shipping

Shipments of high-grade silver-lead ore have been started from the property of Gunsight Mining, near Ajo, Ariz., to the El Paso smelter of American Smelting & Refining. The ore is trucked to Ajo by an Autocar 5-ton truck for shipment. About fifteen men are employed at present, under the supervision of J. D. Mitchell, the superintendent. A 50-ton flotation plant is under construction. New equipment, recently installed, consists of a 50-hp. Fairbanks-Morse Diesel engine, driving a 240-cu.ft. Schram air compressor; a 120-hp. Chicago Pneumatic Diesel for supplying power to the mill; a 35-hp. Hercules hoist; and Cochise drilling equipment.

Considerable development work has been in progress. About 25,000 tons of ore is contained in the mill dumps. Underground, Mr. Mitchell estimates about 100,000 tons of mill-grade ore has been blocked out. Development is through a three-compartment, 400-ft. shaft. Drifting on high-grade streaks is now in progress.

■

C. & H. Cuts Kearsarge in South Hecla Area

Crosscutting from Hecla No. 12 shaft, near Hancock, Houghton County, Mich., has cut the Kearsarge lode on the No. 78 level. Hecla No. 12 shaft is at the southern end of the conglomerate lode, which lies west of and parallel to the Kearsarge lode. Where cut, the Kearsarge was 12 ft. wide, with a good grade of ore. This is the greatest depth at which ore has been found in the Kearsarge lode. A crosscut from the Red Jacket shaft at the No. 81 level disclosed very little copper in the Kearsarge. As the No. 12 shaft is more than a mile south of the Red Jacket, a substantial area is available for lateral development. Until at least some of this work has been accomplished, the importance of the strike cannot be ascertained.

The Kearsarge lode, which lies immediately above the Wolverine sandstone, is the most regular of the large productive lodes in the district, yet it varies considerably in character from place to place. Comparatively little work has been done along the lode in the original Calumet & Hecla area. The main production has been obtained to the north, in Ahmeek and Allouez ground. The deepest workings on the lode, including the productive mines to the north and the three shafts put down in Calumet & Hecla ground, are comparatively shallow. No. 78 level is about 4,750 ft. deep.

■

North Butte Crosscut Shows High-Grade Stringers

North Butte Mining, operating properties in the Butte district of Montana, reports cutting stringers of high-grade copper ore on the 2,200 level of its Main Range group, in the eastern part of the district. In November, 1930, small stringers were encountered in the long southeast crosscut. At present, the crosscut has cut talc seams and is making a considerable flow of water, indicating the proximity of a fissure.

A crosscut southwest of the point where the stringers were originally encountered has cut their extension 70 ft. to the west. This ore is 3,000 ft. southeast of the Main Range shaft. The ore consists of glance, bornite, and chalcocite, assaying as high as 37 to 47 per cent copper. It occurs in a siliceous granite intrusion. Three shifts are now being employed in drifting on the stringers in the hope that they will merge to make a solid vein when the regular Butte granite is reached.

North Butte was the only large copper-silver producer in Montana to report an increased output in 1930. As a result of shipments early in the year. it became the second largest producer of copper in the state. When the price of copper dropped, however, output was curtailed.

Homestake Completing New Ellison Surface Plant

Reconstruction of the Ellison surface plant of Homestake Mining, at Lead, S. D., was almost complete at the beginning of 1931, according to B. C. Yates, general manager of the company. A fire on the evening of July 10, 1930, destroyed the Ellison shaft house and seriously damaged the steam-hoist building, the compressor and crushing plant, the new change room, and other facilities contained in the shaft house. Production had to be slightly curtailed in July and August, inasmuch as the Ellison shaft was the principal hoisting unit for the property, which is the largest gold producer in the United States. Because of the higher grade of ore handled, however, Homestake's production for 1930 was substantially higher than in 1929.

The fire did no damage underground other than that caused by falling cages, skips, and hoisting cables. Work was started at once in removing the débris and twisted steel from the site. The steam hoist and one or two of the compressors were salvaged. A temporary shelter was constructed. By July 24, low-pressure compressor No. 1 was in operation. The steam hoist, used in handling men and supplies, started on Aug. 15; the electric hoist on Oct. 22; other compressors started on Nov. 5 and 15; and the new crushing plant on Nov. 6.

Replacement of a large part of the headframe was necessary. This has now been reinforced and jacked into place. The shaft house has not been rebuilt, each unit being in a separate building as far as possible. All new construction is fireproof. New brick buildings to house the mine carpenter shop and the rope house have been built at detached points to replace part of the old shaft house that was not destroyed in the fire and that left combustible material under the hoisting cables.

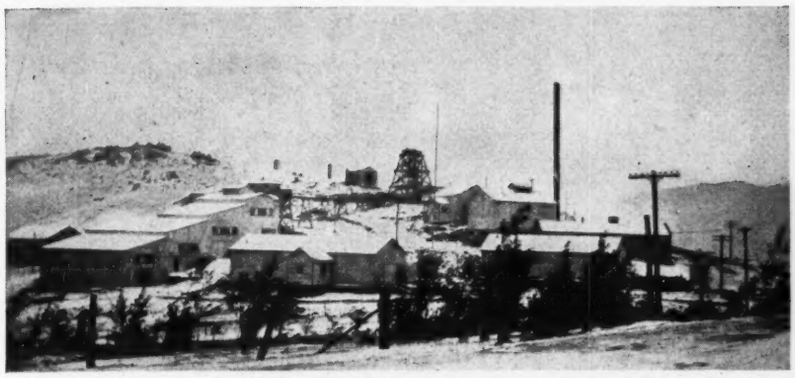
The increase in grade of ore at the Homestake, which averaged $6.19 a ton in 1930, was the result partly of the approaching exhaustion of cheaply won low-grade ore from caved areas of the upper levels and partly of the plentiful labor supply, which permitted a larger proportion of the tonnage to come from the higher-grade timbered areas.

■

A. S. & R. Ships Yankee Ore

American Smelting & Refining is now shipping a small tonnage of copper-gold ore from the Yankee Mines property, in American Fork Canyon, Utah. This ore is being mined in development work, by which the company hopes to be able to increase reserves. During December, shipments totaled only 235 tons. At the Frisco-Lulu mine, in Beaver County, Utah, all work has been suspended. The property is near the Horn Silver mine. A diamond-drill hole is being put down at the Silver Creek holdings of A. S. & R., in the Park City district. Sullivan Machinery has the contract.

An important new lead has been opened up in the Estelle mine of the Estelle-Cerro Gordo unit, Inyo County, Calif., according to A. H. Means, manager of mines for the western division of A. S. & R. This new ore has been opened beyond a fault that cut the ore in the Cerro Gordo mine. In December, shipments from the property were 350 tons, assaying 33 per cent lead and 25 to 30 oz. of silver per ton.



Operations have recently been suspended at this pilot plant, erected by Lake George, at Captain's Flat, New South Wales, Australia, to provide large-scale sampling and experimentation for its complex lead-zinc-copper-silver ore

Mount Lyell Has Reserves of Junore, Chairman Reveals

In addition to the reserves of ore given in its annual report, Mount Lyell Mining & Railway, operating the only important copper-producing properties in Australia, has substantial tonnages of material that may be treated at a profit at some later date, Colin Templeton, chairman of the company, revealed at the annual meeting in Melbourne. Experience had shown that improvements in metallurgy and mining make possible the extraction of material that was once worthless, he pointed out, and stockholders could therefore consider this additional material as a potential asset of some importance.

Of this material, 5,000,000 long tons, averaging 1 per cent copper, is on the Prince Lyell lease and can be mined by power-shovel operations. About 1,000,000 tons averaging 1.5 per cent copper has been found on the Lyell Tharsis and about 500,000 tons, averaging 2 per cent, is available in the Crown Lyell. These deposits are definitely not commercial at present. The lowest-grade section of the property that is now payable is the 2,500,000 tons, assaying 2.25 per cent copper, which is available above the North Lyell tunnel on the Royal Tharsis lease. Production from this source will be started within two years. Recently, a diamond drill has proved that the ore continues at least 187 ft. below the tunnel level, maintaining its average value and uniformity of character.

Mill tonnage is now 20,000 long tons monthly. The work of removing the coarse-crushing unit to a separate site is well under way, and when additional fine grinding and flotation equipment is installed in its place in the mill building, capacity will be 1,000 tons daily. This work will be completed within three months or so.

Extension of the hydro-electric plant, needed to supply the additional power which the company's refinery will require, is nearly completed. The plant will have a continuous capacity of 9,000 hp. and a peak-loading capacity of 12,500 hp. Of this amount, the company is under contract to supply 3,000 hp. to the hydro-electric department of Tasmania. Additions to the refinery, bringing its capacity up to 13,000 long tons annually, have been completed. The company has an accumulation of blister from the smelter which will gradually be worked off.

Jack Waite Completing New 500-Ton Mill

Construction of a new 500-ton concentrator at the property of Jack Waite Consolidated, in the Cœur d'Alene district of Idaho, is expected to be complete by Feb. 1. About $300,000 has been spent on erecting this new plant and improving transportation facilities at the property, which is now under control of J. F. Duthie, of Seattle. At present a 150-ton mill is in operation on the lead-silver-zinc ore produced by the mine.

W. L. Zeigler, metallurgist of Hecla Mining, designed the new mill, which is built on the slope of a hill, about half a mile from the mine. Ore is delivered by electric locomotives into a 300-ton mill bin. It is then fed to a 60,000-lb. 15x24-in. Traylor jaw crusher, which will reduce it to 1½-in. diameter. After washing, the coarse ore is hand-picked on a sorting belt, lighted by mercury-vapor lamps. Another Traylor crusher completes the crushing unit, which has an effective capacity of 1,000 tons daily.

The fine-ore bin has a capacity of 400 tons. Ore is fed from it to an 8x6-ft. ball mill, operating in closed circuit with a Dorr classifier. Classifier overflow passes to a fourteen-cell Minerals Separation Sub-A flotation unit, for recovery of lead content. After double cleaning, the tailing from the lead machine flows to an eight-cell zinc unit. Both lead and zinc concentrates are dewatered by 24x8-ft. thickeners and are then filtered by Oliver filters, the lead filter being 8x8 ft. and the zinc filter, 3x4 ft. Tailing will be flumed to Eagle Creek, 2 miles from the mill. Concentrate will be trucked to the railroad, which is about 1½ miles from the mill.

■

Annual A.I.M.E. Meeting to Be Held on Feb. 16-19

Members of the A.I.M.E. have received the preliminary announcement of the annual meeting that will be held in New York City on Feb. 16-19. As usual, the special features will include a smoker on the first evening of the meeting, an informal dance on the second evening, and the annual reception and banquet on the third evening. Meetings of the technical committees will be held on Monday in the morning and afternoon, Tuesday afternoon, Wednesday morning and afternoon, and Thursday.

At the annual dinner, to be held once again at the Commodore Hotel on Feb. 18, the W. L. Saunders gold medal will be presented to F. W. Maclennan, of Miami Copper; the James Douglas medal to W. H. Peirce, of American Smelting & Refining, and the Robert W. Hunt award to Edmund S. Davenport, of U. S. Steel. The new president, Robert E. Tally, of United Verde, will be introduced and the retiring president, W. H. Bassett, of American Brass, will make his presidential address. Dancing will follow.

Milling methods and geophysical prospecting will be the subjects of technical meetings of interest to non-ferrous metal and non-metallic miners on Monday. On Tuesday, the committee on mining geology has arranged a symposium on gold supply, with consideration given to the various important producing centers throughout the afternoon. Reduction and refining of copper, lead, zinc, and the rare metals will be the topic of another session to be held Tuesday. Wednesday will include meetings on ground movement and subsidence, non-metallic minerals other than the fuels, mining geology, and mine ventilation. The mining methods committee will hold forth on Thursday morning.

The annual business meeting will be held Tuesday morning. A special luncheon for former members of the Rocky Mountain Club will be held at the Engineers' Club on Tuesday, and every day will see luncheons held at the Institute building at 29 West 39th St. At the smoker, to be held in the ballroom of the Hotel Pennsylvania, theatrical entertainment will follow a five-course, informal dinner. The informal dance on Tuesday evening will be at the Grand Central Art Gallery.

■

Dismantling Surface Plant at Butte & Superior

Work of dismantling the surface equipment at the property of Butte & Superior Mining, in the Butte district of Montana, is now under way. All equipment has been removed from underground at the property, the pumps have been pulled, and the mine is being allowed to fill with water, which is already up to about the 3,000 level.

Regular production from the property ceased early in 1930, but some of the old stopes were cleaned out and development was continued on the chance of finding new ore. Such slight hopes as the company may have entertained were disappointed, however. Production of zinc in 1930, according to the U. S. Bureau of Mines, was about 65 per cent less than in 1929, when it amounted to about 25,000 tons.

The company was organized as Butte & Superior Copper in 1906 and changed to Butte & Superior Mining in 1916. Operations were carried to a maximum depth of 3,400 ft. The bulk of the zinc ore was obtained from the Rainbow lode, but development on the 2,000 level in 1921 disclosed a copper vein parallel to the main Rainbow lode and about 400 ft. to the north. Maximum production by Butte & Superior was 627,370 tons of ore in 1916, with a metal content of 195,000,000 lb. of zinc. Although the property had its own 1,800-ton mill, within recent years all ore has been shipped to Anaconda for treatment.

The company paid total dividends of $20,277,531 on the 290,197 shares of stock outstanding. Par value was $10 a share. Dividends were suspended after December, 1929, when a 50c. distribution was made.

Pittsburgh-Goldfield Starts Crosscutting on 500 Level

Crosscutting has been started on the 500 level of the new three-compartment shaft of Pittsburgh-Goldfield Mining, in the eastern section of the Goldfield district of Nevada. As soon as the crosscuts have been driven a sufficient distance from the station, sinking of the shaft, now bottomed at 540 ft., will be resumed. The work is being done under the direction of Corrin Barnes, general manager of the company.

The property of the present company includes four claims that formerly belonged to Pittsburgh-Nevada, and additional ground to the northeast that was acquired by the present owners in 1928. The Pittsburgh-Nevada claims were developed through a 412-ft. shaft as early as 1908, at which depth the vein was proved to be 52 ft. wide. Lateral exploration failed to develop any gold ore, however.

The new three-compartment shaft is about 1,500 ft. northeast of the old workings. It consists of two hoisting compartments and a manway, with total dimensions, outside the timbers, of 7x17 ft. Surface equipment includes a 60-ft. Jones & McLaughlin steel headframe; a double-drum Hendrie & Bolthoff hoist, with a speed of 600 ft. per minute and a maximum pull of 14,000 lb.; a 150-hp. General Electric motor, which supplies power for the hoist; a 528-cu.ft. Ingersoll-Rand compressor, driven by a 75-hp. General Electric motor; an Ingersoll-Rand drill sharpener; and a No. 7 Sturtevant blower, providing 5,000 cu.ft. of air per minute through 2,000 ft. of 19-in. air pipe.

The station on the 500 level was cut to permit handling of timbers and supplies. Its dimensions are 25x16x15 ft. A steel-lined ore pocket, 15x15x12 ft., has been installed below the station level and provided with steel gates. Automatic-dumping skips will be used for hoisting to the surface. To provide power for operations, a 2-mile extension was built from the nearest terminal pole of the Nevada-California Power Company.

■

Western Salt Plans Starting New Plant Unit in April

A modern grainer salt evaporation system is being erected by Great Western Salt at its plant at Salina, Utah. Foundations have been excavated, lumber is on the ground, and machinery has been ordered, preparatory to putting the plant in operation on April 1, according to E. S. Wright, manager of the company. Development of high-grade fuel supplies by Salina Valley Coal, 18 miles from the Great Western Salt deposit, will make possible the production of dairy and table salt. For several years, Great Western Salt has been mining rock salt and shipping it for stock-feeding purposes. Because of its iodine, calcium, phosphorus, and iron content, salt from this deposit is in wide demand.

The company is building a 3-mile pipe line to furnish fresh water; a 30x48-ft. boiler house, two 50x76-ft. grainer houses; and a 50x95-ft. warehouse, 75-ft. high. A coal pit, with a capacity of 100 tons of fuel, will be excavated near the company's branch railroad line. Boiler equipment will consist of two 150-hp. boilers, fired by Jones automatic stokers.

Surface plant and headframe at Pittsburgh-Goldfield

Brine will be conducted to an 8x40-ft. pre-heating tank, where the solution will be heated to near boiler temperature. In common with the pre-heating tank, the two grainer tanks, 16x70 ft., will be lined with steam pipe. An automatic rake will scrape the salt crystals off the tank bottom and on to a 100-ft. belt conveyor, which will carry them to a curing bin, where the water will be drained off. The salt is then sent to an oil-fired rotary kiln dryer, 60x5 ft.

■

Kildun Mining Shipments Paying All Expenses

Kildun Mining, operating a silver-gold property in the Matehuala district, San Luis Potosi, Mexico, is now on a regular shipping basis of 100 tons of ore daily, according to J. H. A. Williams, president of the company. The receipts from these shipments are fully meeting the expenses of developing the property, which adjoins the famous Santa Maria de la Paz mine. In recent shipments, furthermore, the gold content has proved to be greater than the silver content of the ore, although Matehuala is normally a silver district. One vein has consistently given returns of $20 to $60 a ton, according to Mr. Williams, with some assays lower and some higher. Recent development has added 300 ft. to the known depth of this vein.

Work has been started on the 1,475 level, with crosscuts being driven north and south. These crosscuts are expected to cut the downward continuation of the orebodies developed on the 1,000 level. The ore is expected to be sulphide at 1,475 ft., as at the La Paz property the change from oxide to sulphide occurs at about 400-m. depth.

■

Report Huge Nugget Find

Discovery of a huge nugget at Larkinville, Western Australia, is described in a cable dispatch to the New York *Times* of Jan. 19. It was found about 18 in. below ground, and weighs more than 94 lb., or about 1,500 oz., indicating a value of about $25,000 to $30,000. A gold rush, "reminiscent of pioneering days," is reported.

A letter from our Melbourne correspondent, dated Dec. 23, 1930, describes the finding of a 50-oz. nugget at Larkinville, which is 50 miles from Coolgardie, in the Kalgoorlie district. Several other nuggets weighing from 10 to 35 oz. have been found. The first report of activity from the district was received late in October, when about 200 oz. was recovered within a fortnight.

■

Ship High-Grade Gold Ore From Landusky, Mont.

A shipment of high-grade gold ore has recently been made from a small orebody developed in the "Old August" workings of the August Mining property, a few miles north of Landusky, Phillips County, Mont. The property is now being operated by Norman Holter, who was interested in the Alta mine; Charles Powers, former owner of the Block P mine, now operated by St. Joseph Lead; George McGee, formerly manager of Barnes King Development; and Charles Whitcomb, who has interests in the Ruby Gulch and Beaver Creek mines, in the same district.

Development has indicated that the high-grade orebody is about 25 ft. long and 5 ft. wide. The 40 tons contained in the most recent shipment netted about $300 per ton. Prospecting in the Little Rocky Mountains, in which the property is situated, has been considerably stimulated by the find.

■

Golconda Drifts at 1,800 Ft.

Crosscutting on the 1,800 level of the Golconda Lead property, at Wallace, Idaho, in the Coeur d'Alene district, struck the downward extension of the orebody, and drifting along it is now under way. Where cut, the ore was 5 ft. wide. On the 1,600 level, the ore when cut showed a width of 9 ft., and on the 1,400 level the average width was about 8 ft. The grade is said to be up to expectations.

Shaft sinking will now be resumed, with the intention of opening up the 2,000 level of the mine. The shaft is a three-compartment vertical unit and has been put down from the main Golconda tunnel. Milling operations are confined to treatment of lead-zinc ore from development work. A surface strike of high-grade galena was recently made on the surface of the Golconda property, on what appears to be the outcrop of the Mayflower vein. It is to the east of the tunnel.

Quincy Strikes Two Lodes in Crosscut on 82 Level

Both the East and Main Pewabic lodes have been cut by a crosscut from the No. 82, or bottom, level of No. 8 shaft of the Quincy mine, in the Michigan copper district. The lodes are wide and contain ore of good grade.

The remodeled hoist at No. 6 shaft, Quincy, which now has a capacity equal to that of the No. 2 hoist, is showing the expected efficiency in operation. The system of braking by means of compressed air, employed in this hoist, is in every way satisfactory. Production is still on a curtailed basis, the smelter being run whenever sufficient concentrate has been accumulated.

■

Parallel Vein Is Reported at New Nevada Gold Camp

Discovery of a parallel vein at Scossa, formerly Rabbit Hole, Nev., has been the most important recent development at Nevada's newest gold "boom" camp. The parallel vein is reported to have been found by the Olsen brothers and their associate, G. Noble. It lies about 600 ft. northeast of the point at which the Scossa brothers, original discoverers of the camp, are putting down a shaft. The grade is reported to be as high as $10 a pound. Press reports, widely printed, put the value of the sacked material shipped from the Scossa claims in December at about $5 a pound.

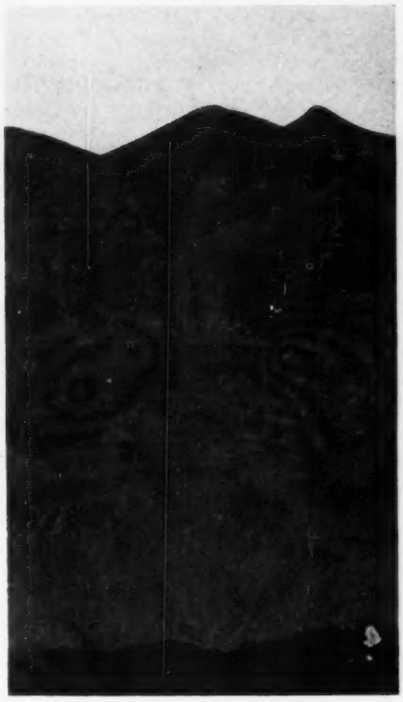
Reports have been printed that Charles Scossa, one of the two discoverers, has optioned the property, which he and his brother control, to a syndicate of Eastern bankers. Further details are lacking. In the meanwhile, a windlass has been installed on their claims and they plan to sink to 60 ft. The shaft is 4 ft. square and is already down more than 10 ft., with gold still showing. Scossa is 26 miles northeast of Seven Troughs, and about 50 miles north of Lovelock, Nev.

■

Oatman Mines to Co-operate

Further development of the United American gold property, at Oatman, Ariz., will be undertaken through the adjoining Tom Reed mine, according to an agreement made at a meeting of United American stockholders on Jan. 15. The Tom Reed east drift on the 1,100 level will be continued 400 ft. into United American ground, where the oreshoot that has been opened on the United American 1,000 level should be encountered. The 1,000 level will be about 160 ft. above the continuation of the Tom Reed 1,100 level. A raise will probably be put up then to connect with the United American shaft, should development come up to expectations. Ore shipped from the 1,000 level averaged $19.38 a ton in gold.

Production from the Tom Reed property continues at the rate of $100,000 monthly. A raise put up from the 800 level recently struck an unexpected oreshoot, which is being followed up toward the 600 level. Development of the orebody on the 1,100 level is being continued.



One of the glory holes through which ore is now being mined at Sacramento pit, in its Copper Queen unit, Bisbee, Ariz., by Phelps Dodge

■

Deepen Vipond Workings

Vipond Consolidated, operating in the Porcupine district of Ontario, will sink its main shaft from 1,200 to 1,450 ft., and open up new levels at 1,325 ft. and 1,450 ft. In addition, the Porcupine Crown property will be reopened and crosscuts will be extended into that ground. A start has already been made on the 1,000 level, which is being extended 2,000 ft. west to cut into Porcupine Crown territory. Another crosscut is being driven west on the 400 level to facilitate unwatering. Porcupine Crown paid dividends on ore averaging $10 a ton, but was forced to suspend work on its main vein when it dipped east toward the Vipond boundary. Ore reserves at Vipond are now equal to nearly two years of operation at the rate of 300 tons daily.

■

Ashanti Reports Record Month

Ashanti Goldfields, probably the highest-grade gold producer of its size in the world, reported a record month at its property at Obuassi, Gold Coast, in December. A total of 11,620 tons of ore was milled for a recovery of 13,958 oz. of fine gold, indicating a daily tonnage of 371. Total profit for the month, after provision for depreciation, was £33,412.

Underground developments at the property continue favorable. In addition to cutting the orebody on its new and deepest level, the No. 26, at a distance of 355 ft. from the shaft, a crosscut on No. 24 level cut the orebody at a point where it is 6 ft. wide and averaged 34.7 dwt. of gold per ton. Two previous crosscuts, in the same area, showed the ore 5 and 7 ft. wide, with assays of 18.2 and 47.7 dwt., respectively. The company is averaging more than 650 ft. of development work a month.

Hotchkiss Starts Conferences on Low-Grade Iron Deposits

A series of conferences to consider the problem of utilizing the Lake Superior iron formations when present commercial grades are no longer sufficient to supply the demand has been started by Dr. W. O. Hotchkiss, president of the Michigan College of Mining and Technology, at Houghton. The first of these conferences was attended by representatives of mining companies operating in Michigan. At this meeting, which was recently held in Houghton, present knowledge and ideas bearing on the subject were co-ordinated and a preliminary outline was drawn up as to what should be done to get needed studies under way.

This is part of the research program instituted at the college by President Hotchkiss to assist in the solution of iron and copper problems. The desirability of calling the iron conferences was recently presented to the Lake Superior Iron Ore Association by Dr. Hotchkiss and approval of the plan was wholeheartedly given.

The research staff at the college has been doing preliminary work for three years, getting ready for the intensive study of the low-grade iron ores; now it is planned to start the organized study of the mines and the iron-bearing rocks in the field. It is realized, however, that the finding of ways to utilize low-grade ores is a hard, time-consuming operation that will require many years.

The state tax commission estimates taxable iron-ore reserves sufficient for about twelve years of operation. The time being short, it is felt that adequate study of ways to perpetuate the indusry should get under way at once. This work, however, can be continued only if the state legislature grants the request of the college for an appropriation of $75,000 per year for the coming biennium.

■

Objects to Tin Quota Scheme

Frank Mair, chairman, at the annual meeting of Rambutan Tin Mining, said: "I have three objections to the tin quota scheme. First, the initial curtailment is inadequate; second, the scheme does not prevent mines from producing and storing of tin ore in excess of their exportable allowance as result of which, unless legislation by all countries prohibited hoarding of tin ore, there would be a huge accumulation ready to be exported as soon as the scheme ceased to operate, militating against a sustained rise in price; third, I object to basing the ratio of each country on the 1929 output."

■

New Tunnel at Union Gold

Union Gold Mining, operating a property at Atlantic City, Wyo., will drive a new 1,100-ft. tunnel to tap five vein systems at a depth of from 250 to 500 ft., according to J. G. Marzel, state geologist of Wyoming. The vein varies from 2.5 to 21 ft. in width. During 1930 the company confined its operations to the McGrath claim, making a small production of gold bullion in its new 75-ton amalgamation and flotation plant, which is said to have cost about $100,000 to build. Total Wyoming production in 1930 was $6,578 in gold, the largest since 1916.

Development at Kalgoorlie Trends to Northern Area

Development work in the northern section of the Kalgoorlie district of Western Australia, Australia, is tending to disprove the long-standing theory that geological formations in this section of the "Golden Mile" were not favorable to ore deposition. Two properties in particular—North Kalgurli and Croesus Proprietary—have responded favorably to development within the last year.

North Kalgurli now holds a total area of 147 acres, of which 66 acres is its original lease and the remainder is the property it acquired from Oroya Links in 1928 in exchange for 383,333 shares. The mine had been developed in the vicinity of the Kalgurli lode and the Associated Northern Blocks' leases, but only within the last two or three years has work been done in the virgin country in the northern section of the property. A new shaft was sunk to about 1,000 ft. and work has been undertaken on six levels. At present, about 200,000 tons ore averaging 63s. per ton is estimated to be in sight. During November, 1930, 560 tons was treated in the South Kalgurli mill and returned £2,346, or slightly better than £4 per ton.

The company has an old twenty-stamp mill on its property, but it is situated at some distance from the new shaft. To reduce costs and facilitate handling the ore, the mill location will probably be changed in the future. If the flotation treatment, now being applied with success at Lake View & Star, continues to give good recoveries of Kalgoorlie ore, the company will probably install flotation equipment in the plant. Two new Babcock boilers have been added to the power equipment.

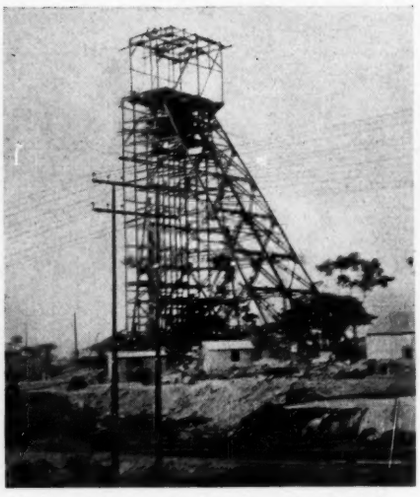
At Croesus Proprietary, which is owned by North Kalgurli, but which has been leased to South Kalgurli on a profit-sharing basis for ten years, the mine has been thoroughly overhauled. Production during the last year has increased from 1,200 to 2,500 tons monthly. Ore, which occurs in talc schist, has been developed through four levels, of which the deepest is at 1,200 ft.

An oreshoot now being worked has been proved for a length of 300 ft. and a stoping width of 20 ft. Between the 1,050 and 1,200 levels, a reserve of 70,000 tons, averaging 10 dwt. in gold per ton, is estimated. Average grade for the property is about 8 dwt. Although ore is now milled at the South Kalgurli plant, construction of a separate flotation plant is anticipated.

■

To Investigate Yukon Con.

On the application of a large group of English shareholders, headed by J. T. Patton, the Hon. C. H. Cahan, Secretary of State for Canada, has ordered an investigation into the affairs of Yukon Consolidated Gold. G. T. Clarkson, of Toronto, has been appointed to conduct the investigation. The applicants claim too much stock has been issued and that the affairs of the company have been mismanaged. The company is capitalized at $6,000,000. It holds large placer gold concessions in Yukon Territory, but is not to be confused with Yukon Gold, the Guggenheim subsidiary, or Yukon Gold Mines, which operates a silver-gold lode deposit at Tagish Lake, in the territory.



One of the main shafts at the N'Kana mine, in Northern Rhodesia

Agassiz Writes Woods on Copper-Mine Employment

Copper companies are taking care of laborers and their families despite conditions prevailing in that industry, according to a statement received by Colonel Arthur Woods, chairman of the President's Emergency Committee for Employment, from R. L. Agassiz, president of the Copper and Brass Research Association and chairman of the board of directors of the Calumet & Hecla Consolidated Copper Company.

"I can assure you that the copper industry is doing everything possible to sustain employment during this winter," writes Mr. Agassiz. "There has been some shortening of weekly working hours, but I think I can say that in all the mining communities the laboring men and their families are being taken care of. In the case of our firm, the Calumet & Hecla Consolidated Copper Company, we are now working our mines four days a week. We have closed down certain of our activities, but the men employed there have been taken care of elsewhere. The factors which stand in the way of complete employment in the copper industry are the general depression in that industry and a large overproduction which has resulted in the accumulation of very unwieldy stocks of the metal."

This letter is typical of many received by the President's Emergency Committee following the distribution of two pamphlets entitled "An Outline of Industrial Policies and Practices in Time of Reduced Employment and Operation" and "A Survey of Unemployment Relief in Industry." These reports seek to give a brief summary of what industries are doing and can do in the present economic situation. Copies may be obtained from the committee on request.

■

Remodel Cloverdale Plant

Nevada Quicksilver has remodeled the 100-ton quicksilver plant at its Cloverdale property, Sonoma County, Calif., and is said to be producing about ten flasks daily. A wire-rope tramway is being constructed to the company's Beaumeister property, which it recently acquired, and shipments of ore will be started when it is ready.

Pour First Refined Silver at Ontario Refining Plant

On Jan. 16 refined silver was poured for the first time in the new precious-metals refinery in connection with the custom copper plant of Ontario Refining, at Copper Cliff, Ont. Previously, the silver content of the nickel-copper ores of the Sudbury district was contained in the matte which was shipped either to Port Colborne, Ont., or Clydach, Wales. Within the first week approximately 100,000 oz. of silver were shipped, and it is expected monthly shipments from now on will amount to about 140,000 oz. The crucible furnace for the refining of gold has also been started and bullion will be poured about Jan. 23. A small amount of platinum and palladium and some selenium will also be recovered.

In the design and construction of the refinery special provision was made for the severity of northern Ontario winters as compared with the climate of Carteret, N. J., where the other copper refinery in which American Metal is interested is situated. Initial experience with the refinery has been satisfactory, according to C. H. Aldrich, manager, who informs the *E. & M. J.* correspondent that, in spite of a difference of about 35 or 40 deg. in temperature, up to the present there has been less trouble with frozen pipes at Copper Cliff than at Carteret. In the layout of buildings at the Ontario refinery all the operations were housed, extra heavy building material and roofing was used, and double windows were among the provisions made for the additional severity of climate.

■

Teck-Hughes Gold Preparing to Sink Shaft to 7,000 Ft.

In keeping with its announced policy of extending mine workings to a depth of 7,000 ft. and ultimately, if possible, to 10,000 ft., Teck-Hughes Gold Mines, operating in the Kirkland Lake district, Ontario, is making preparations to continue shaft sinking from the present bottom level of the mine at 3,600 ft., to the No. 55 level, at 6,725 ft. This will entail a program extending over at least three years and will also entail heavy expenditures on shaft sinking and hoisting equipment.

The actual preparations at present consist of excavating large underground chambers on the 3,600 or No. 30 level for the installation of new electric hoists. These, it is understood, will duplicate the present surface hoisting equipment. Actual sinking will probably not be started until late in the current year.

■

Form Bannockburn Company

A subsidiary company, named the Ashley Gold Mining Corporation, has been formed by Mining Corporation of Canada through which the development of the Ashley-Garvey discovery in Bannockburn Township, Matachewan district, Ontario, will be carried out. The capitalization will be 3,000,000 shares of $1 par. Four drill holes completed to date have proved the continuation of the gold-bearing vein to a depth of 85 ft. over a length of 175 ft. A small gasoline plant has been ordered to proceed to the property immediately to start sinking on the vein, to be followed by a heavier steam-driven plant, at an early date.

House Cuts Appropriation for U. S. Bureau of Mines

Appropriations of $2,278,765 for the Bureau of Mines for the year beginning July 1 next are provided by the House Committee on Appropriations in the Department of Commerce appropriation bill, which is $270,715 less than is available during the current year and $35,620 less than the estimates of the Budget Bureau.

In testimony before the committee Director Scott Turner stated in reply to an inquiry by Representative Tinkham that there had been a 20 per cent decrease in mining in 1930 as compared with 1929. Mr. Tinkham thought the services of the Bureau would be less required because of the decrease in mine activity, but Director Turner pointed out that the work of the Bureau is not linked directly with the production rate of mines, but is fundamental, involving investigation and research. Representative Oliver was also inclined to think that as mining operations decrease, the press on the services of the Bureau falls off. Asked by Representative Griffin what branch of mining had suffered the greatest production decline, Director Turner said silver was the most seriously affected, the price being so low that among mines producing principally silver ores the percentage of shutdowns is large. In reply to questions by Representatives Tinkham and Griffin, Mr. Turner said competition from Russian coal is not likely to become serious in this country.

Commenting on mine explosions, Representative Griffin said the government investigates these disasters but "finds its hands tied, and there is no public profit from it except what may go to the mine owners, in whose discretion the report may be released." He favored a change in the methods of handling the investigations. Director Turner gave a list of 24 mine fires in which 5 persons were killed, 34 explosions in which 199 were killed, and 29 accidents in which 72 were killed, and the causes, during the year ended June 30, 1930. "If the safety recommendations of the Bureau had been fully complied with, most of these explosions would not have occurred," said Director Turner.

■

Name Organization Committee for Geological Congress

Officers and members have been chosen for the committee on organization of the sixteenth International Geological Congress, which will meet in Washington, D. C., in 1932. The invitation of the United States was accepted at the fifteenth Congress, held in Pretoria, Union of South Africa, in 1929. Waldemar Lindgren, of the Massachusetts Institute of Technology, has been appointed chairman of the committee, of which President Herbert Hoover is honorary president. E. B. Mathews, of Johns Hopkins University, is treasurer, and W. C. Mendenhall, now acting head of the Geological Survey, is secretary of the committee.

The general sessions, which will be held early in June, will be preceded and followed by a series of excursions designed to afford members and attendants opportunity to see features of special geological interest in the United States. A preparatory list of topics for discussion has been drawn up, but offers of papers or suggestions of additional topics are requested.

BRIEF NOTES

Arizona Quicksilver Corporation. According to R. B. Stilzer, resident engineer of the company, operations will be resumed at the properties at Slate Creek, north of Roosevelt, Ariz. Disseminated cinnabar deposits, occurring in shear zones in Pre-Cambrian schist, associated with quartz and calcite, have been developed through several tunnels. A twelve-pipe retort furnace, with a capacity of 50 tons daily, has been constructed.

Beattie (Quebec). The syndicate that is financing exploration of this low-grade gold prospect, in Duparquet Township, Quebec, is reported to have cut 100 ft. of vein matter in the first hole put down. The entire width yielded low gold assays. Surface sampling is reported to have indicated a deposit about 300 ft. long and 30 ft. wide, averaging between $4 and $5 per ton in gold.

Bibiani (1927), Ltd. Development at the company's holdings, about 50 miles northwest of Obuasi, Gold Coast Colony, Africa, has indicated that the property does not carry a large, low-grade gold deposit but that it has some material that can be treated at a profit. J. S. Watkins, the consulting engineer, estimates that 150,000 tons averaging 11 dwt. in gold per ton is in sight, in addition to some high-grade sections in the so-called "big bulge," for which no estimate can be made, although, once discovered, these shoots can be treated at a profit. Nos. 1 and 4 shafts have now been connected on the No. 3 level, where ore is 300 ft. long and 9 ft. wide. Driving on the No. 4 level is now in progress.

Bullion Canyon Gold. At the property, near Marysvale, Utah, a tunnel is being driven south on a quartz vein to an intersection with a northeast-southwest fissure. Mining equipment includes a small Sullivan compressor, Fordson tractor, and Ingersoll-Rand and Gardner-Denver drills.

Commonwealth Lead. Completion of the new 600-ft. tunnel being driven at the property, near Melrose, Mont., is expected early in February. It is expected to cut the vein 400 ft. below the upper workings. A raise will be put up when the vein is reached. In the meanwhile, shipping operations have been temporarily suspended.

Consolidated Mining & Smelting. The new fertilizer plant at Trail started to produce triple superphosphate and mono-ammonium fertilizer on Jan. 1. By next September, the output will be raised to the capacity of the first unit, or about 400 tons of fertilizers daily.

Consolidated Coppermines. The Interstate Commerce Commission has decided that the company's complaint with regard to freight rates on shipments of lumber to the property at Ely, Nev., from Pacific Coast points is justified and has declared the rates charged by the Nevada Northern and other railroads to be unreasonable. According to the commission, the company had been charged 74.5c. per 100 lb. on shipments of mining timbers from Oregon and Washington; 53c. from Truckee-Hawley, Calif.; 65.5c. from Oroville, Calif.; and 73c. from Placerville. The commission declares that reasonable rates would have been 62.5c., 47.5c., 55c., and 55c., respectively. Consolidated Coppermines, under the decision, is entitled to reparation from the railroads for the overcharges. In addition, the rates will be lowered to the basis found reasonable by the commission.

Copper Chief Mining. A crosscut is now being driven on the 650 level of the company's property in the Plomosa district, Yuma County, Ariz. Mineralization is expected to be reached within a distance of 600 to 700 ft. Sinking of the two-compartment shaft cut a copper deposit at a depth of 280 ft. Mineralization is found along a lime-schist contact cut by intrusive greenstone dikes. Richard Darling, president of the company, is in charge of operations.

El Oro Mining & Milling. The company expects to have its 40-ton pilot mill at the Allison gold property, 70 miles southwest of Tucson, in operation before Feb. 1. Stamp milling and amalgamation, followed by table concentration, will be used for recovery of the gold and silver content of the ore, as previous attempts to use flotation have met with indifferent success. The company has started driving a tunnel that is expected to intersect the vein 300 ft. from its portal. Present development is largely through a 625-ft. inclined shaft, from which levels have been driven at 100-ft. intervals. The gold occurs in a crushed zone along the contact of rhyolite and andesite.

General Kieselguhr Corporation. The company has acquired the property of the Mount Shasta Silica Company, in Shasta County, Calif. Deposits of diatomite were exploited for a short time, and a grinding plant was built, but the original company failed.

H. W. Gould & Company. Development and shaft sinking have been in progress at the Oat Hill quicksilver property, in Napa County, Calif., which the company is operating. Production is reported to be between 60 and 90 flasks monthly.

Granada Rouyn. Difficulty in obtaining sufficient water for milling operations necessitated a twelve-day suspension at the property, near Rouyn, Que. Underground work was continued, however, thus increasing the reserves of broken ore. The shaft is about to be deepened to 1,000 ft. so as to permit a larger production from the mine. At present about 60 tons of ore, averaging $16 in gold per ton, is being handled.

Mazapil Copper. Development work has been resumed at the company's properties, near Concepcion del Oro, Zacatecas, Mexico. Low metal prices caused a complete suspension on Sept. 15. Lead and copper are the chief metals produced, but some of the lead ores contain an appreciable amount of silver. British interests control the company.

Mohawk Mining. Shaft sinking at the Michigan mine, in Ontonagon County, Mich., has reached a point below the No. 14 level. A station is now being cut, and when this work is completed sinking will be resumed to the 2,000 level. Development of the Calico, Butler, and other lodes will be undertaken at that depth.

Montana Phosphate. Present shipments to the new fertilizer unit of Consolidated Mining & Smelting at Trail, B. C., are averaging 100 tons daily. Four trucks transport the phosphate to

(*Continued on Page 86*)

EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

Tin Restriction Hinges on Malayan Agreement

London, Jan. 17.—Market men here see the entire tin situation as hinging on the success of the new plan for restriction of production in the four leading countries. As the Malayan government, which is the largest single factor in tin production, is still undecided, a general air of uncertainty is definitely noticeable. Nigeria, Bolivia, and the Netherlands East Indies have all fallen in line with the proposal, which envisages a ratio of 78 per cent of production during the last three years. One very favorable factor is that the Mair-Osborne-Chappel group is not reported to be in favor of the scheme. Recently A. G. Glenister, a director of the group, stated that the Federated Malay States government had no intention of rushing into the agreement.

. . . . Kamunting Tin, one of the larger Malayan dredging enterprises, operating in Perak, has decided not to resume in its Kamunting Panga area in February, as it had originally planned to do. The indecision of the government is reported to be the reason for the failure to proceed.

. . . . Ashanti Goldfields, the bonanza gold producer on the Gold Coast, reports a net profit of £320,561 for the year ended Sept. 30, 1930, which compares with £203,584 in the preceding year. The company has added £30,000 to its exploration account, probably in connection with the work being done at the Bibiani mine (see Brief Notes), which it controls. In addition, the company has increased its reserve fund £25,000 to £275,000 and is in a very strong financial position. In fact, a scrip bonus of one new share for every two shares held has been announced, which will mean increasing the capital by 625,000 new 4s. shares. Ore reserves at the mine were increased during the fiscal year to 607,600 tons, averaging 24.7 dwt. in gold per ton, as compared with 590,200 tons, averaging 25.2 dwt. per ton, at the end of last year.

. . . . The labor dispute at Broken Hill, New South Wales, which threatened to force the suspension of operations at all properties in that important silver-lead-zinc district, has been settled. North Broken Hill, largest producer in the district, has announced resumption of operations at its property. Settling of this dispute will not help the lead market, which had strengthened temporarily on the possibility that the important Australian supplies might be shut off.

. . . . . Duncan Alves and Hugh Marriott, of the Panama Corporation, are leaving next month for Panama to be present when production starts at the company's Remance and alluvial properties. Developments in the Remance mine are reported to continue satisfactory. The 100-ton mill is expected to start in March.

. . . . Kagera (Uganda) Tinfields is increasing its capital by 100,000 6 per cent convertible preference shares, with a par value of 5s. At present the company has 400,000 common shares outstanding. The company has a large area in Uganda Protectorate to prospect, in addition to one producing property at Mwirasandu. Funds now available will permit mine development to continue during curtailment of production.

■

Record Transvaal Gold Output 300,000 Oz. Above 1929

Johannesburg, Jan. 17.—Production of gold in the Province of Transvaal in 1930 was 10,717,188 oz., valued at £45,558,980, the highest that it has ever been and an increase of more than 300,000 oz., or about £1,300,000, over the record established in 1929. The 1929 figures were 10,412,326 oz., valued at £44,236,141. Production in December was 905,920 oz., which compares with 884,753 oz. in November, and the record month of 926,561 oz. in October. Increased labor supply, a very slight reduction in costs, and an improvement in grade are all partly responsible for the increased production. No new producers of importance were added to the Rand list during the year, but several of the larger plants have increased the tonnage handled.

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Broken Hill Vanadium Unit Starts Operations

London, Jan. 17.—Operation of the new vanadium unit at Broken Hill Development, in Northern Rhodesia, has been started. The company expects to produce about 10 long tons of vanadic oxide in January, 20 tons in February, and a minimum of 30 tons monthly thereafter. If necessary, the plant can produce a maximum of 600 tons annually, and it has been so constructed as to facilitate further expansion of capacity. Large stockpiles of high-grade vanadium ore have been accumulated on the surface of the property, and certain sections of the company's zinc-lead deposits also carry high vanadium content.

. . . . Hole NE 48, at the N'Changa West Extension property of Rhodesian Congo Border, has cut high-grade sulphide or between 1,325 and 1,340 ft. This hole has already passed through 50 ft. of ore averaging 5.32 per cent copper in the Upper or Dambo lode horizon, and first entered ore at 1,300 ft. in the Lower or River lode horizon. The first 25 ft. averaged only about 4 per cent copper.

. . . . At a meeting of Rhodesian Anglo American, the increase in the company's capitalization to £6,500,000 by issuing £2,000,000 in debentures was approved. This issue will allow the company to take £2.500,000 of the forthcoming Rhodesian Congo Border debentures.

. . . . Pending construction of a railroad to the property, work at the Kansanshi mine of Rhodesia Katanga is being confined to extension of known ore reserves, as development and construction will be much cheaper when rail transportation is available. In the meanwhile, the design of the plant is being prepared by A. E. Wheeler. Kansanshi will start entirely as an open-pit operation, and there will be virtually no overburden to remove. The most important recent development has been the recent crosscutting of 109 ft. of ore averaging 9.5 per cent copper between the "A East" and "A" veins on the 150 level. A diamond drill from the surface, to check this discovery, showed a vertical thickness of 72 ft. averaging 5.5 per cent ore.

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Brief Notes

(*Continued from Page 85*)

the railroad at Deer Lodge, Mont. About fifty men are employed. Shipments will gradually be increased to 600 tons daily, according to Floyd Scott, superintendent of the property. The rock runs 75 per cent bone phosphate of lime and nets $6 per ton.

Outokompu. Production of ore from this property, in southeastern Finland, was about 175,000 short tons of ore, averaging 4 per cent copper, in 1930. The ore is treated in a 500-ton concentrator and the concentrates are shipped to Germany for smelting. The Finnish government operates Outokompu. Ore reserves are estimated at about 8,500,000 tons and the deepest drill holes put down to date indicate that the orebody is 24 to 30 ft. wide at the bottom.

Siscoe Gold. At the property, near Rouyn, Que., development through the new central shaft is being centered on the western vein system, previously indicated by diamond drilling. More than 250 ft. of exploration has been done on the vein on the 300 level, and on the 450 level it has just been reached by crosscutting. Mill tonnage will be increased to 150 tons daily in February. Although additions to mill equipment have been completed, overhauling of the power equipment is necessary before the increase can be put into effect. Average grade of ore handled in 1930 was $11.11 and the recovery was $10.88.

United States Potash. Sinking of the four-compartment shaft at the company's property, 23 miles east of Carlsbad, N. M., has reached 900 ft. Potash was struck at 500 ft. and has been continuous since that point, but sinking will be continued to 1,000 ft. before the work of blocking out and mining is started. About 600 ft. of the shaft has already been lined with concrete. Large-scale production is contemplated, including the construction of a branch railroad to Carlsbad and the erection of a treatment plant there.

MARKET AND FINANCIAL NEWS

Trend in Stocks of Copper Continues Downward

The December copper statistics for North and South America showed a reduction in total stocks of 7,138 tons. The reduction in stocks in November amounted to 11,963 tons. Figures released by the American Bureau of Metal Statistics indicated a drop in stocks of blister of 4,481 tons, and a decline in stocks of refined of 2,657 tons. Total stocks of blister and refined at the end of December stood at 585,974 tons, against 593,112 tons a month previous, and 605,075 tons on the last day of October.

Production of refined copper in North and South America totaled 106,366 tons, against 112,646 tons in November. The daily rate for December was 3,431 tons, against 3,755 tons in the preceding month, and an average of 3,998 tons for the year. Production of refined in 1930 amounted to 1,459,370 tons, against 1,811,857 tons in 1929, 1,627,849 tons in 1928, and 1,476,506 tons in 1927.

Primary copper production by United States mines in December totaled 48,518 tons, against 53,141 tons in November, and 55,954 tons in October. The Lake mines cut production from 6,209 tons in November to 4,876 tons in December.

Summary of Copper Statistics

In Tons of 2,000 Pounds

Production:	November	December
Mines, United States	53,141	48,518
Blister, North America (a)	76,449	74,186
Blister, South America (a)	22,580	20,752
Refined, No. & So. America	112,646	106,366
World, blister basis	139,914	(c)
Stocks (end of month):		
No. and So. America:		
Blister (b)	223,280	218,799
Refined	369,832	367,175
Totals	593,112	585,974
Great Britain (d)		
Refined	6,311	6,443
Other forms	2,628	2,153
Totals	8,939	8,596
Havre	4,711	3,896

(a) Includes direct-cathode copper. (b) Includes in process. (c) Not yet available. (d) Official warehouses only.

U. S. Mine Production

	November	December
Porphyry mines	19,887	19,000
Lake mines	6,209	4,876
Vein mines	23,945	21,142
Custom ores	3,100	(a) 3,500
Total crude production	53,141	48,518
Daily rate	1,771	1,565

(a) Partly estimated.

Smelter Production

	November	December
United States	64,816	60,022
Canada	7,678	9,508
Mexico	3,955	4,656
Totals	76,449	74,186

Copper Shipments

North and South America

	Export	Domestic	Total
1926	525,861	902,174	1,428,035
1927	641,865	824,844	1,466,709
1928	674,221	983,460	1,657,681
1929			
January	57,054	100,135	157,189
February	50,150	98,771	148,921
March	59,946	105,860	165,806
April	57,708	99,051	156,759
May	55,123	93,743	148,866
June	48,461	95,258	143,719
July	40,204	98,720	138,924
August	45,035	96,970	142,005
September	45,921	98,043	143,964
October	53,461	105,729	159,190
November	37,879	68,979	106,858
December	35,652	58,150	93,802
Totals	586,594	1,119,409	1,706,003
1930			
January	30,358	69,932	100,290
February	29,597	61,879	91,476
March	30,523	73,644	104,167
April	29,196	50,017	79,213
May	49,115	75,760	124,875
June	44,818	71,887	116,705
July	42,466	75,436	117,902
August	38,319	56,810	95,129
September	37,873	65,169	103,042
October	38,246	75,703	113,949
November	45,051	62,693	107,744
December	39,169	69,854	109,023
Totals	454,731	808,784	1,263,515

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Canada Reports Increased Metal Output for 1930

New records were established in 1930 by Canada in the production of gold, silver, copper, lead, and zinc, according to the official estimate of the Dominion Bureau of Statistics. Because of the drastic reduction in metal prices and on account of lower outputs in many of the non-metallic minerals, the total value of Canada's mineral production in 1930, amounting to $276,865,000, decreased 11 per cent from the record output of $310,850,246 created in 1929.

Gold production in 1930 passed the two-million-ounce mark for the first time, the output being 2,089,766 oz.

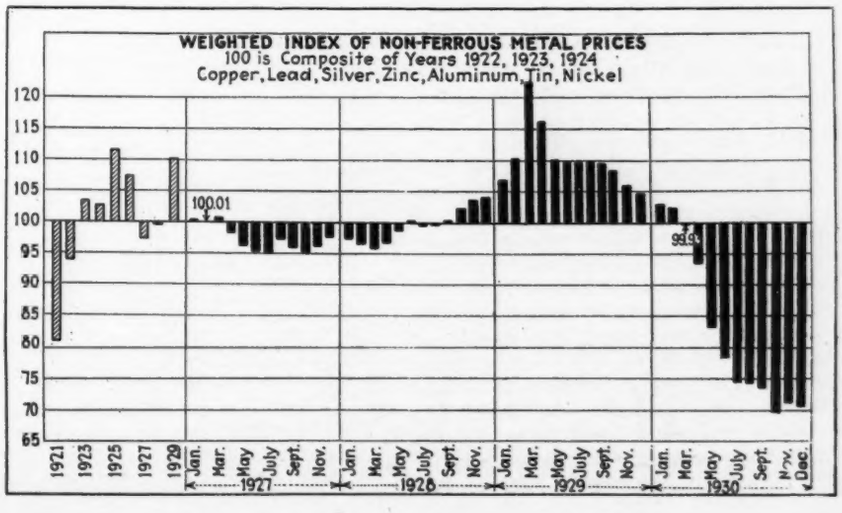
Silver production totaling 26,171,651 oz. was 13 per cent greater than that of 1929, but on account of the low average yearly price the value of the production was 18 per cent below that of 1929.

Copper production totaled 301,017,167 lb., valued at $38,687,000, against 248,120,760 lb., valued at $43,415,251, in the previous year, an increase of 21 per cent in quantity but a decrease of 11 per cent in value.

Nickel production at 103,782,000 lb. was about 6 per cent under the 1929 output. Nickel matte was shipped to Port Colborne, to Clydach, Wales; to Huntington, in West Virginia, and to Norway.

Official estimate of the mineral production of Canada for 1930, with comparable figures for 1929, follows:

	1929 Quantity	1930 Quantity
Metals—		
Gold, oz	1,928,308	2,089,766
Silver, oz	23,143,261	26,171,651
Nickel, lb	110,275,912	103,782,009
Copper, lb	248,120,760	301,017,167
Lead, lb	326,522,566	329,033,531
Zinc, lb	197,267,087	259,700,849
Non-Metals—		
Fuels		
Coal, tons	17,496,557	14,925,000
Natural gas, M. cu.ft.	28,378,462	29,566,000
Peat, tons	2,607	3,000
Petroleum, bbls.	1,117,368	1,500,000
Other Non-Metals		
Asbestos, tons	306,055	244,000
Feldspar, tons	37,527	26,000
Gypsum, tons	1,211,689	1,060,000
Mica, tons	4,053	1,200
Quartz, tons	265,949	200,000
Salt, tons	330,264	283,000



United States Silver Output Reduced in December

Silver produced in the United States during December amounted to 3,450,000 oz., according to the American Bureau of Metal Statistics, making the total for the year 49,971,000 oz., against 60,180,000 oz. in 1929, and 56,149,000 oz. in 1928.

Canada is credited with an output of 2,043,000 oz. for December, and a total of 23,447,000 oz. for 1930. Canadian production for 1929 was 21,587,000 oz., and in 1928, 20,328,000 oz.

Mexico produced 8,889,000 oz. of silver in October, the latest month reported by that country, which contrasts with 9,154,000 oz. in September.

World output for October is estimated by the Bureau at 17,745,000 oz., against 19,118,000 oz. in September, and 22,686,000 oz. in October, 1929.

Production statistics for the months of October, November, and December, 1930, in thousands of ounces, by countries, follow:

	Oct.	Nov.	Dec.
United States	3,816	3,738	3,450
Canada	2,291	1,412	2,043
Mexico	8,889	(a)	(a)
Peru	1,480	677	508
Australia	709	712	674
Burma	560	571	(a)

(a) Not yet available.

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Decline in Silver Production Smaller Than Expected

World production of silver in 1930 declined approximately 17,000,000 oz. from the previous year's total, according to the annual review of the silver situation by Handy & Harman. Production for the year is estimated at 243,700,000 oz., of which the United States supplied 50,400,000 oz., Mexico 105,700,000 oz., and Canada 26,200,000 oz. South America contributed 22,700,000 oz., chiefly from Peru, and all other countries accounted for 38,700,000 oz. In view of the low prices for silver, the shrinkage of 6½ per cent in world output, the review holds, failed to fulfill the predictions of much greater curtailment.

Touching on the supplies of silver derived from other sources than production, the summary adds that "estimates vary as to the amount of metal which came upon the market as a result of demonetization and sales from government reserves, but it would appear that this figure was larger in 1930 than in the preceding year. Debasement of British coinage continued, although the amount derived from this source is not publicly known, as the Royal Mint re-coined the metal for domestic currency and for foreign governments. Supplies from demonetized French coin amounted to about 22,000,000 oz. more; and sales by the Indian government contributed another 29,500,000 oz., making a total of 71,500,000 oz. from sources other than new production.

Production of silver for 1929 and 1930, as estimated by Handy & Harman, follows:

World Production
(In millions of ounces)

	1929	1930
Production:		
United States	61.2	50.4
Mexico	108.7	105.7
Canada	22.4	26.2
Other countries	68.6	61.4
Totals	260.9	243.7
Other supplies:		
Debasement of British coinage	10.0	.....
Demonetized coin:		
France	10.0	22.0
Indo-China	12.0	20.0
Sales by Indian government	35.0	29.5
Grand totals	327.9	315.2

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Brownell Advocates Plan to Stabilize Silver

A plan for the stabilization of the price of silver through co-operation of various governments is proposed by Francis H. Brownell, chairman of the board of the American Smelting & Refining Company, in a survey of the silver situation. The plan outlined by Mr. Brownell does not raise the question of bimetallism, or of any permanent fixed ratio between gold and silver. The initiative in the proposed international movement, he says, would naturally come from England or the United States, the two leading financial nations most directly affected by world trade conditions.

The arrangement need not be formal in its nature, Mr. Brownell points out, but the governments should each publicly announce its policy and the agreement should last for a sufficient time for a fair trial. Its immediate effect would be to remove from the market the present threat of sales by governments. The fall in the price of silver, in his opinion, was not due to current overproduction, but to the sales of silver formerly used as money by the different governments.

In last analysis the plan is a commercial union, such as is formed in times of panic by leading banks and banking houses to protect the security market. In this case the members will be nations instead of corporations or individuals.

The stabilization of silver prices at no fixed ratio to gold involves three elements, Mr. Brownell says:

"First—and most important—an informal understanding between the United States, England, including India; France, including Indo-China; and as many other governments as possible, that no sale will be made, for a stated period, say three years, or until further notice, of any silver now or hereafter owned by each government at less than some fixed price, say, for example, 50c. per ounce.

"Second, an understanding that those governments will purchase the amount of silver they are now authorized by law to purchase for subsidiary coinage whenever the price of silver in the open market is below the figure to be agreed upon as above.

"Third, as compensation for agreeing as provided in 'First,' and to prevent too rapid a rise, an understanding that the governments, and particularly India, may sell government-owned silver whenever the price is more than, say, 5c. above the figure agreed upon as above."

Fundamentally, the plan is directed toward a restoration of trade in that portion of the world which seems to be most depressed—the silver-using countries.

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CONSOLIDATED COPPERMINES, operating in Nevada, reports net income for the third quarter of 1930 at $59,242, before provision for depreciation, depletion, and federal income tax. The company produced 7,560,595 lb. of copper, 3,741 oz. of gold, and 8,285 oz. of silver. Output is now curtailed about 33 per cent.

ASHANTI GOLDFIELDS, operating on the Gold Coast, Africa, reports net profit of £33,412 from a production of £59,293 in December. This is the best month in the company's history.

Mining Company Dividends for January, 1931

Companies in the United States	Situation	Per Share	Total Disbursements
Aluminum Company of America, pfd.	Various	$1.50 Q	$2,214,930
Bunker Hill & Sullivan, l., s.	Idaho	0.25 M	122,625
Bunker Hill & Sullivan, pfd.	Idaho	2.00 Q	15,313
Cresson Consolidated, g.	Colorado	0.01 Q	12,000
Eagle-Picher Lead, pfd., l., z.	Oklahoma, Missouri	1.50 Q	12,770
Homestake Mining, g.	S. Dakota	0.50 M	125,580
Kennecott Copper	Various	0.50 Q	4,686,061
Magma Copper	Arizona	0.75 Q	306,116
National Lead, pfd., "B"	Various	1.50 Q	154,913
Newmont Mining, h.	Various	1.00 Q	452,760
Phelps Dodge, c.	Various	0.50 Q	1,411,270
Silver King Coalition, s., l., z.	Utah	0.15 Q	183,070
U. S. Smelting, Refining & Mining	Various	0.25 Q	121,587
U. S. Smelting, Refining & Mining, pfd.	Various	0.875 Q	425,557
United Verde Extension, c.	Arizona	0.50 Q	525,000
Companies in Other Countries			
Consolidated M. & S., l., z., s.	Canada	6.25 SAB	3,185,837
Dome Mines, g.	Canada	0.25 Q	238,333
Greene Cananea, c., s., g.	Mexico	0.75 Q	375,000
Hollinger Consolidated Gold	Canada	0.05 M	246,000
Howe Sound, c., l., z.	Mexico, Canada	1.00 Q	496,038
Nipissing, s.	Canada	0.075 Q	90,000
Premier Gold, s., g.	Canada	0.03 Q	150,000
Wright Hargreaves, g.	Canada	0.05 Q	275,000
Total			$15,825,760

c, copper; s, silver; l, lead; z, zinc; g, gold; h, holding; Q, quarterly; M, monthly; SAB, semi-annual, $1.25, plus $5.00 bonus.

Lead Production in U. S. Up During December

Lead production in the United States from domestic ore during December totaled 48,517 tons, an increase of 5,094 tons over November, according to the American Bureau of Metal Statistics. Shipments reported for December amounted to 40,595 tons, the lowest monthly total for 1930. Stocks at the end of December stood at 103,247 tons, against 90,402 tons in November, and 51,076 tons at the beginning of 1930.

Lead production, stocks, and shipments, in tons, follow:

Production	Nov.	Dec.
From domestic ore	43,423	48,517
Secondary and foreign	5,565	4,692
Totals	48,988	53,209
Stock at beginning (a)	84,375	90,402
Total supply	133,363	143,611
Stock at end (a)	90,402	103,247
Shipments by difference	42,961	40,364
Shipments reported	43,062	40,595

(a) Domestic only.

The United States lead refinery statistics account for refineries at Omaha, Selby, Perth Amboy, Carteret, Collinsville, East Chicago, Herculaneum, Grasselli, Federal, Kellogg, Galena, Newark, Matawan, Indianapolis, Joplin, and Ontario.

The industrial classification of domestic lead shipments, for 1929 and 1930, according to the American Bureau of Metal Statistics, in tons, follows:

	1929	1930
Cable	202,924	196,550
Ammunition	31,741	37,446
Tin foil	29,868	17,285
Batteries	81,239	56,313
Brass-making	2,978	2,080
Sundries	39,533	35,141
Jobbers	8,216	6,948
Unclassified (a)	386,556	285,621
Totals	783,055	637,384

(a) Of the shipments reported as unclassified, about one-third goes into white lead and about 30 per cent into red lead and litharge, as averages. Other important outlets in this classification are sheet and pipe, solder, and babbitt metal.

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Iron Ore Mined in U. S. in 1930 Down 20 per Cent in Volume

Iron ore mined in the United States in 1930, exclusive of ore that contained 5 per cent or more of manganese in the natural state, is estimated by the U. S. Bureau of Mines at 58,359,000 gross tons, a decrease of 20 per cent compared with that mined in 1929. The ore shipped from the mines in 1930 is estimated at 55,094,000 gross tons, valued at $145,888,000, a decrease of 27 per cent in quantity and of 26 per cent in total value compared with the figures for 1929. Average value of the ore per gross ton at the mines in 1930 is estimated at $2.65; in 1929 it was $2.61. Stocks of iron ore at the mines, mainly in Michigan and Minnesota, apparently increased from 7,067,206 gross tons in 1929 to 10,430,000 tons in 1930, or 48 per cent. The Bureau of Mines estimates are based on preliminary figures furnished by producers who in 1929 mined about 99 per cent of the total iron ore.

The following table shows the quantity and value of the iron ore mined in the United States by the principal producing states. The figures for 1929 are final, but those for 1930 are subject to revision.

District	Ore Mined (Gross Tons) 1929	1930
Lake Superior:		
Michigan	15,456,397	13,668,000
Minnesota	45,760,858	34,385,000
Wisconsin	1,608,571	1,325,000
	62,825,826	49,378,000
Southeastern states:		
Alabama	6,453,075	5,710,000
Georgia	59,316	53,000
Missouri	168,934	127,000
North Carolina	30,675	.....
Tennessee	102,171	28,000
Virginia	.....	19,000
	6,814,171	5,937,000
Northeastern states:		
New Jersey	281,327	390,000
New York	822,261	890,000
Pennsylvania	1,092,013	965,000
	2,195,601	2,245,000
Western states	1,192,122	799,000
Totals	73,027,720	58,359,000

Imports of iron ore reported for the eleven months ended Nov. 30, 1930, amounted to 2,599,204 gross tons, valued at $7,676,638, or $2.95 a ton. Imports for 1929 were 3,139,334 gross tons, valued at $8,145,354, or $2.59 a ton. The reported exports of iron ore for the eleven months ended Nov. 30, 1930, amounted to 752,082 gross tons, valued at $2,733,423, or $3.63 a ton, compared with exports for the entire year 1929 of 1,304,417 tons, valued at $4,774,842, or $3.66 a ton, according to the Bureau of Foreign and Domestic Commerce.

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Financial Notes

LORNE GOLD MINES, operating in the Bridge River district of British Columbia, has declined the offer of Bralco Development & Investment of $95,000 for payment on the property and additional funds for development in return for a 60 per cent interest.

DOME MINES, operating in the Porcupine district of Ontario, reports net profit of $117,895 in a preliminary earnings statement for 1930. Production from its new 1,500-ton mill in November and December was $398,064. Recovery of gold from mill wreckage was $377,202.

GOLDFIELD CONSOLIDATED and GOLD HILL DEVELOPMENT, Nevada companies, have been listed on the Philadelphia Commercial Exchange. Other mining securities, able to meet the exchange requirements, are expected to be admitted to trading privileges from time to time.

ALASKA JUNEAU'S estimated results for December, 1930, operations show 325,990 tons mined and trammed to mill; production, $323,000, or 99.08c. per ton; operating expenditures, $168,000, or 51.54c. per ton; operating profit, $155,000, or 47.54c. per ton. Other expenditures and accrued charges totaled $5,900, leaving $149,100 to surplus for the month.

Malayan High Commissioner Approves Tin Export Plan

Sir Philip Cunliffe Lister, chairman of the Tin Producers' Association, London, announced on Jan. 17 that the scheme for regulating tin output by a system of international quotas had the approval of Sir Cecil Clementi, high commissioner of the Federated Malay States, and that the Malayan government had been assured the support of a great majority of Malayan companies as well as individual producers, both British and Chinese, in Malaya. The Dutch East Indies, Bolivian, and Nigerian governments had already approved the scheme.

Sir Philip pointed out (1) that the international agreement will remain in force two years; (2) that the quota ratio allotted to Malaya is on equal terms with the aggregate allotted to the three countries already signatories to the agreement; (3) the essence of the agreement is correlation of world production to consumption and gradual reduction of the existing excessive stocks so that producers may definitely count on a better price.

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December Tin Statistics

The tin statistics for December and November, and for December, 1929, as compiled by the National Metal Exchange, in long tons, follow:

	Dec. 1930	Nov. 1930	Dec 1929
Supplies—			
Straits	7,065	8,540	8,950
Australia	55	65	80
Banka	4,391	1,202	1,276
Chinese	448	317	405
Standard	1,196	1,449	3,103
Totals	13,155	11,573	13,8114
Deliveries—			
U. K., all kinds	954	1,032	1,861
U. S., all kinds	7,495	6,270	5,740
Continent, all kinds	2,027	2,155	2,145
Other ports	992	981	1,099
Totals	11,468	10,438	10,845
Stocks—			
U. K., all kinds	22,423	22,379	13,019
U. S. A., all kinds	4,693	5,372	2,820
Continent, all kinds	Nil	Nil	Nil
Totals	27,116	27,751	15,839
Afloat			
U. K., all kinds	420	597	1,783
U. S. A., all kinds	8,234	8,805	7,041
Continent, all kinds	6,728	3,658	3,477
Totals	15.382	13,060	12,301
Visible supply	42,498	40,811	28,140

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Record Ontario Gold Output

Production of gold in Ontario, Canada, was at a new high point for all time in December, when an output of $3,576,658 was recorded, compared with $3,063,865 in the previous month. Operation of the new Dome mill and the increase in Lake Shore milling capacity are responsible for the rise. The total for the year was $35,385,274 from the mines at Kirkland Lake, Porcupine, and the Howey, at Red Lake. Grade at the last-named property has been improved.

Lead Declines Further—Fair Export Trade in Copper at Steady Prices—Zinc Quiet

New York, Jan. 22, 1931.—The trend of prices for major metals in the last two weeks was downward, though the changes which took place in that period were not particularly significant. Lead was reduced 10 points, resulting in some good business for January-February shipment. Copper again fell to the 10c. Connecticut basis, and the export quotation was brought down to this level without much delay. Export business in copper has improved. Zinc held around 4c. throughout the period. Further progress was reported in the new scheme for stabilizing the tin market. Silver sold down to 28½c. per ounce in New York, a new low, but steadied toward the close on good buying by India and covering by shorts. Antimony prices hardened somewhat on support in China. Quicksilver was quiet and offerings were reported at concessions.

Copper at 10c.

The price of copper declined to the basis of 10c., delivered Connecticut, early in the period, but failed to arouse much buying interest, owing to the continued slow movement of copper products into consumption. The reduction in the domestic market was followed by a corresponding drop in the export price, which, however, increased foreign orders to an extent that custom smelters were able to dispose of their current intake. Foreign sales for the month to date amounted to 28,500 long tons. The export price was reduced from 10.80c. to 10.55c. on Jan. 9, and to 10.30c. on Jan. 10. On Jan. 16 a premium of 5 points was put into effect on forward business to induce foreign buyers to take prompt copper.

The December copper statistics for North and South America showed a reduction in total stocks of 7,138 tons.

Good Lead Sales

Lead was reduced to 4.75c., New York, and 4.55c., St. Louis, on Jan. 8, the third decline since Jan. 5. The decline was attributed to no other cause than to stimulate business. In the week ended Jan. 14 the sales were highly satisfactory, totaling about 8,500 tons. Lead statistics for December were disappointing, in that stocks increased by 13,000 tons and production from domestic ore increased by 5,094 tons. Year-end smelter clean-ups accounted for much of the increase in output.

Zinc Sales at 4c.

Consumer buying of zinc products has shown no improvement to speak of, and this was reflected in the quiet which prevailed in zinc during the last two weeks. The price showed scarcely any change, holding around 4c., St. Louis, on near-by material, and at 4.025c. on forward business. Zinc concentrate in the Tri-State market has been firmer, though unchanged on the basis of $26 per ton for prime, 60 per cent zinc.

Tin Steady

Tin was steady on the strength of further progress in the negotiations for world-wide acceptance of the plan to restrict shipments over the next two years so as to bring about some degree of stability in prices. Consumers did a little buying in the domestic trade.

Silver Closes Firm

After selling down to 28½c., New York, a new low, the silver situation appeared to improve. The market closed at 30c., with the undertone firm on buying for India and covering by shorts. The fact that India has again entered the market for silver attracted wide attention.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 7⅞c.; futures, 7⅛c. Cookson's "C" grade, spot, 12⅞c. "C.M.C." grade, 99.9 per cent, spot, 10¾c. London, Chinese, spot, £24@£24 10s. per long ton.

BISMUTH—Per lb., in ton lots, $1.25. London, 5s.

CADMIUM—Per lb., 70c. London, 1s. 9d. to 1s. 10d.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron.

COBALT—Per lb., delivered: Metal imported from Belgium in the form of rondelles, 97@99 per cent, spot, $2.50. Discounts on contracts. London, spot, 10s. Nominal.

INDIUM—Per gram, minimum 99 per cent, $14@$15.

IRIDIUM—Per oz. $160@$190 for 98 @99 per cent sponge and powder. London, £33@£35.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 48c., in 100-lb. lots or more; 2½- or 3-lb. sticks (1⅛x27 in.), 53c., 100-lb. lots or more. London, 2s. 9d.@3s. for 99 per cent ingots or sticks.

MANGANESE—Per lb., 95@97 per cent, 42c.

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9.50; 97 per cent, $6.50@$7. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb.: ingot, 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent), for single lots of spot metal. London, per long ton, £170@£175, as to quantity.

OSMIUM—Per oz., $65@$70. Nominal. London, £15@£17.

PALLADIUM—Per oz., $21@$22. London, £3 15s.@£4.

PLATINUM — Per oz.; Official price of leading interest, $36. Cash transactions between dealers and refiners at several dollars less. London quotes £6 10s. to £7. Average price of Colombian crude, basis 85 per cent platinum, for November was $26 per oz.

QUICKSILVER—Per 76-lb. flask, $103. Market quiet. London, £22 7s. 6d. for spot material.

RADIUM—Per mg. radium content,

Complete Market News and Prices

THE semi-monthly magazine you are now reading carries only a condensed review of important market news and price movements. For buyers and sellers of ores, metals, minerals, and scrap who require reliable information as soon as it is available, we now provide *Metal and Mineral Markets*, which goes to press at the close of the metal-market week each Wednesday. It is printed at high speed and is in the mails that evening. In compact form, ready for insertion in a ring binder, it is ideal for desk and reference use. It carries the standard *E.&M.J.* quotations used in contracts the world over, recognized as authoritative and dependable. *Metal and Mineral Markets* is priced to subscribers in the United States and its possessions at $2 per annum; to countries in the Americas but outside the United States, $5; elsewhere, $10 yearly: 52 issues. Address *M.& M.M.*, 36th St. and 10th Ave., N.Y.City.

Daily Prices of Metals

Jan.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
8	9.775@10.025	27.00	4.75@4.85	4.55@4.60	4.00 @4.025
9	9.775	26.375	4.75	4.55	4.00 @4.025
10	9.775	25.875	4.75	4.55	4.00 @4.025
12	9.775	25.75	4.75	4.55	3.975@4.025
13	9.775	25.75	4.75	4.55	4.00
14	9.775	25.65	4.75	4.55	4.00
Av'ge	9.796	26.067	4.758	4.554	4.006
15	9.775	25.55	4.75	4.55	4.00
16	9.775	26.20	4.75	4.55	4.00
17	9.775	26.35	4.75	4.55	4.00
19	9.775	26.10	4.75	4.55	4.00
20	9.775	25.80	4.75	4.55	4.00
21	9.775	26.375	4.75	4.55	4.00
Av'ge	9.775	26.063	4.750	4.550	4.000

Average metal prices for calendar week ended January 10, 1931, are: Copper, 10.004c.; Straits tin, 26.721c.; New York lead, 4.858c.; St. Louis lead, 4.650c.; Zinc, 4.027c.; Silver, 29.333c.

Average metal prices for calendar week ended January 17, 1931, are: Copper, 9.775c.; Straits tin, 25.875c.; New York lead, 4.750c.; St. Louis lead, 4.550c.; Zinc, 4.000c.; Silver, 29.229c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms or wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Jan.	Sterling Exchange "Checks"	Silver		Gold, London	Jan.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
8	4.85 1/2	28 3/4	13 7/16	85s 0 3/4d	15	4.85 1/4	29 1/8	13 11/16	85s 0 d
9	4.85 1/4	28 1/2	13 3/16	85s 0 d	16	4.85 3/16	28 1/2	13 3/8	84s 11 3/4d
10	4.85 5/16	29 3/8	13 1/4	.....	17	4.85 3/16	29	13 3/8	.....
12	4.85 1/4	29 7/8	13 1/16	85s 0 3/4d	19	4.85 1/4	28 7/8	13 1/2	84s 11 3/4d
13	4.85 1/4	30 1/8	14 1/16	85s 0 3/4d	20	4.85	29 1/8	13 3/8	84s 11 1/2d
14	4.85 1/4	28 3/4	13 1/4	85s 0 1/4d	21	4.85 1/8	30	14	84s 11 1/2d

Average for week ended January 14: Silver, 29.229c.; Sterling Exchange, $4.85260.
Average for week ended January 21: Silver, 29.104c.; Sterling Exchange, $4.85146.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-sixteenths cent premium.

London

Jan.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3M	Spot	3 M
8	45 3/16	45 5/16	48 1/2	120	121 1/2	14 5/8	14 3/8	13 1/16	13 9/16
9	44 11/16	44 3/4	47 3/4	117 5/8	119	14 5/16	14 5/16	13 1/8	13 5/8
12	44 9/16	44 7/16	47	114 3/4	116	14 3/8	14 3/4	13 1/4	13 5/8
13	44 3/4	44 1/2	47	113 5/8	115	14 5/16	14 3/8	13	13 3/8
14	44 11/16	44 9/16	47	114 1/2	115 3/4	14 1/2	14 1/2	12 5/8	13 1/16
15	44 9/16	44 7/16	47	113	114 3/8	14	14	12 11/16	13
16	44 9/16	44 7/16	47	114	115 1/4	13 3/4	13 3/4	12 7/16	12 7/8
19	45 1/8	45 1/2	48	116 1/2	117 3/4	13 3/4	13 3/4	12 5/8	12 7/8
20	45 1/16	44 7/8	47 1/2	114 7/8	116 1/4	13 11/16	13 3/4	12 9/16	12 13/16
21	45	45	47 1/2	117 1/4	118 3/4	13 3/8	13 11/16	12 5/8	12 7/8

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

$50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $55. Nominal.

RUTHENIUM — Per oz., $46@$48. Nominal. London, £9@£9½.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure. London, 7s. 8d.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powdered, $1.65.

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s. 9d.@4s. for 60 per cent sulphide ore.

BERYLLIUM ORE—Per unit of BeO, minimum 11 per cent BeO, $4@$5, f.o.b. mines. Per lb. BeO contained, 30c., c.i.f. European ports.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $19.50 for 46@48 per cent Cr_2O_3 ore, and $24 for 50@51 per cent ore. London, 77s. 6d. for 48 per cent Rhodesian, and 80s.@95s. for Indian and New Caledonian, according to quality.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Colorado, per long ton unit, f.o.b. mines, 20 to 23 per cent, 6½c.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per unit:

North African and Swedish, low-phosphorus, 9½@10c.

Spanish and North African basic, 50@60 per cent, 9@9½c.

Swedish foundry or basic, 65@68 per cent, 10c.

Newfoundland foundry, 55 per cent iron, 9c.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 25c.; Chilean, 47 per cent minimum, 30½c.; Indian, 48@50 per cent, 26@27c.; Caucasian, 52@55 per cent, 25@26c.; South African, 52@54 per cent, 25@26c., nominal. Domestic, f.o.b. *Colorado* mines, 20 to 25 per cent, 30c.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $60. Javan or Caucasian, 85 per cent minimum, $60. Domestic, 70 to 72 per cent, $60, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 35@40c., delivered Pittsburgh. London, per long ton unit, nominal at 32s. 6d.@35s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb. Ta_2O_5, 75c. for 60 per cent ore. Per lb., f.o.b. *New Mexico* mines, crude ore with minimum 40 per cent Ta_2O_5, 85c.; 35 per cent, 65c.

TIN ORE — No market in United States. London, returning charge on 60 per cent Bolivian, £9@£10 per long ton; on 70 per cent Nigerian, £6 17s. 6d.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7 @$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Chinese wolframite, $11.50@$12, duty paid. Bolivian scheelite, $11.50 @$12, and domestic, $12. Crude, low-grade ores, f.o.b. *Colorado,* $10 basis for 60 per cent WO_3.

VANADIUM ORE—Per lb. V_2O_5 contained, 26@28c., f.o.b. shipping point.

ZIRCON ORE — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

Tons of 2,000 lb., unless otherwise noted.

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent lithium oxide, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $250@$300; crude No. 2, $200@ $250; spinning fibers, $150@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $30@$35; cement stock, $15@ $20; floats, $10@$12. Market dull.

Per ton c.i.f. New York: Rhodesian crude No. 1, $350; No. 2, $250. Nominal.

Per ton, c.i.f. New York: Russian crude, No. 1, $210; No. 2, $160; No. 3, $50. Nominal.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent, 200 mesh, $47; 100 mesh, $44.

BARYTES—F.o.b. mines, bags extra:

Georgia: Barytes ore, crude, $6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 93 per cent $BaSO_4$, less than 1 per cent iron, $6.50; 1 per cent iron and 93 per cent $BaSO_4$, $6, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@ $12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@ $6.50; one dealer reports $7 for material running 52@54 per cent alumina and 1.50 per cent silica; market fair. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8; 56 per cent Al_2O_3, 1.50 per cent SiO_2, $7; 58 per cent Al_2O_3, 3@4 per cent SiO_2, $6.50.

BENTONITE—Per ton, f.o.b. Wyoming mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

[1]CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $4.50; crushed to ¼ in., $6; pulverized, $9.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Imported English, f.o.b. American ports: lump, $15@$25 in bulk.

EMERY—Per ton, f.o.b. *New York,* domestic crude ore, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30 @$35. F.o.b. *Pennsylvania,* in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina,* 200 mesh, white, $18, in bulk; f.o.b. *Maine,* white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina,* $10.50, in bulk.

Virginia, No. 1, 325 mesh, $18; 200 mesh, $15@$16; 160 mesh, $14; No. 1 glassmakers', $11.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $16. Foundry lump, 85-5, $18. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. *Colorado* mines, 82-5, $12.75.

FULLER'S EARTH — Per ton, f.o.b. *Colorado,* $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida,* 30 to 60 mesh, $18; 15 to 30, $16.50; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines: crude or mill run, $45; unwashed grades, $85; washed, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50.

GRAPHITE—Per lb., f.o.b. *New York:*

Ceylon lump, 7@8½c.; chip, 6@7c.; dust, 2@3c.; Madagascar flake, 6@8c.

No. 1 flake, 8@16c.; fine ground, 5c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20. No. 2 grade, $15.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa,* $2.50; *Ohio* and *New York,* $3. Ground, *Ohio,* $4; *Iowa,* $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton.

MAGNESITE—Per ton, f.o.b. *California* steel mill points, dead-burned, $29. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico,* scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire,* roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina*: Punch, 4@6c.; 1½x2 in., 25@35c.; 2x2, 45@60c.; 2x3, 85c.@$1; 3x3, $1.40 @$1.60; 3x4, $1.80@$2; 3x5, $2@ $2.25; 4x6, $2.75@$3; 6x8, $3.50@ $3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh,

$60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale) —Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia.*

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $20 barrels; second grade, $10. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia,* dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground, 80 per cent through 300 mesh, 33 per cent P_2O_5, $11.80 per net ton, bags extra.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13@13¾c.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots, colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 20c. Flawless, for optical purposes, four times above price; larger crystals still higher.

SILICA—Per ton, water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]SPODUMENE — Per ton, $50@$60 depending upon lithium content.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 88@91 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified.

New Jersey: Soapstone, ground, $10@$12.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $6@$7.75; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 19¾c.; wire, f.o.b. mill, 11¾c.

LEAD SHEETS — Per lb., full rolled, 7¾c.; clipped, 8c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 16⅜c.; plates, 19⅛c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 24½@25c.; 18 per cent, 27¾@28¼c. Wire and rods, 10 per cent, 28c.; 15 per cent, 31¾c.; 18 per cent, 35¼c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 31c.; wire, 5 per cent, 31½c.; 10 per cent, 37c.

ZINC SHEETS — Per lb., 9½c., f.o.b. works; ribbon, 9c.; 7 per cent discount on orders for 18 tons or more.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £18 10s. for Cornish white.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black, 70@71 per cent contained Co, $2.10. London, 8s. for black; 8s. 10d. for gray.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 4c. for either large or small crystals.

GERMANIUM DIOXIDE—Per gram, in 200- to 300-gram lots, $3.50.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $2.05.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $15@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M., first quality, $43, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35@$38.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania,* $43; *Alabama,* $50@$51; *Illinois* and *Indiana,* $52.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, 17½c.; maximum 0.10 per cent carbon, 26c.

FERROMANGANESE — Per gross ton furnace; domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $39, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.10@$1.15, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $120 for maximum 2½ per cent carbon; $130 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

Iron, Steel and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17.50, basic and No. 2 foundry, $17.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $30; plates and structural shapes, per 100 lb., $1.65; soft steel bars, $1.65.

COKE—Per ton, Connellsville furnace, $2.40@$2.50. Connellsville foundry, $3.25@$4.85. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham, foundry, $5, furnace, $3.50@$4.50.

[1]Price furnished by Foote Mineral Company, Philadelphia.

Freight Rates on Metals, Ores, and Concentrates

Carload Lots

Copper Bullion and Refined Copper

From	To	Rate per Ton of 2,000 Lb. All Rail	Via Gulf
El Paso, Tex.	Baltimore, Md.	$11.40	$9.40
Garfield, Utah	Perth Amboy	12.50	.....
Garfield, Utah	San Francisco	5.85	.....
Hayden, Ariz.	Perth Amboy	14.50	12.50
Miami, Ariz.	Perth Amboy	14.50	12.50
Anaconda, Mont.	Perth Amboy	12.50	.....
Butte, Mont.	Perth Amboy	12.50	.....
Humboldt, Ariz.	Carteret, N. J.	14.50	12.50
Douglas, Ariz.	Perth Amboy	14.50	12.50
Globe, Ariz.	Perth Amboy	14.50	12.50
Clifton, Ariz.	Perth Amboy	14.50	12.50
Clarkdale Ariz.	Carteret, N. J.	$14.50	$12.50
Copperhill, Tenn.	Laurel Hill, N. Y.	10.80	.....
Tooele, Utah	Carteret, N. J.	12.50	.....
McGill, Nev.	Baltimore, Md.	12.90	.....
Houghton, Mich.	New York	9.60	.....
Hancock, Mich.	New York	9.60	.....
Hubbell, Mich.	New York	9.60	.....
Dollar Bay, Mich.	New York	9.60	.....
Anaconda, Mont.	Tacoma, Wash.	7.09	.....
Ajo, Ariz.	New York	14.50	12.50

Marine Freight Rates

New York to		Lead	Copper
Hamburg	per gross ton	$5.25	$6.50
Liverpool	per gross ton	6.50	6.50
Antwerp	per gross ton	5.25	6.50
Havre	per gross ton	5.25	6.50

Gulf ports to

Hamburg	$4.75	per gross ton lead and zinc
Liverpool	5.00	
Antwerp	4.25	
Havre	4.75	

Pacific coast ports to

Hongkong	$5.00	per short ton copper and lead
Kobe	4.00	per short ton copper and lead

Lead Bullion (Pig Lead Where Shown)

From	Rates per Ton of 2,000 Lb. To New York	To St. Louis
East St. Louis, Ill.	$5.00 (c)	.....
	7.00	.....
Leadville, Colo.	12.50	$9.00
East Helena, Mont.	12.50	9.50
El Paso, Tex.	10.00 Via Gulf	
	12.00 All Rail	7.00
Omaha, Neb.	8.10	3.10
Murray, Utah	12.50	9.00
Midvale, Utah	12.50	9.00
Tooele, Utah	12.50	9.00
East Chicago, Ill.	4.50 (c)	(a) 2.00
Kellogg, Idaho	13.50	9.50
Carnegie, Pa.	3.80	(a) 5.00
Selby, Calif.	(b)	.....
Herculaneum, Mo.	(a) 6.80	(a) 1.80
Federal, Ill.	(d) 5.00	(a) 2.00
Collinsville, Ill.	(d) 5.00	(a) 0.25
Granby, Mo.	(a) 8.50	(a) 3.50
Joplin, Mo.	(a) 8.50	(a) 3.50

(a) Pig lead only.
(b) Open rate, via canal.
(c) Proportional rate.
(d) Ex Smelter in transit.

Slab Zinc

From	Rates per Net Ton to E. St. Louis	New York
Donora, Pa.	(a) $4.60	$3.80
Langeloth, Pa.	(a) 4.60	3.80
Palmerton, Pa.	7.10	3.00
Hillsboro, Ill.	1.40	7.00
Danville, Ill.	1.60	6.40
LaSalle, Ill.	1.60	6.70
Springfield, Ill.	3.00	7.00
Cleveland, Ohio	5.80	5.00
Moundsville, W. Va.	4.40	3.80
Van Buren, Ark.	3.50	10.50
Fort Smith, Ark.	3.50	10.50
Bartlesville, Okla.	3.50	10.50
Blackwell, Okla.	3.50	10.50
Henryetta, Okla.	3.50	10.50
Sand Springs, Okla.	3.50	10.50
Cherryvale, Kan.	3.50	10.50
Black Eagle, Mont.	8.50	12.50
Park City, Utah	9.00	12.50
Amarillo, Tex.	(b) 5.50	12.50

(a) To St. Louis, Mo.
(b) Proportional Rate.

Zinc Ores and Concentrates

To	From	Rate per Net Ton
Bartlesville, Okla.	Altoona, Kan.	$2.10
	Pittsburg, Kan.	1.09
	Galena, Kan.	1.30
	Joplin, Mo.	1.40
	Iola, Kan.	1.09
	Baxter, Kan.	1.50
	Miami, Okla.	1.40
	Quapaw, Okla.	1.40
	Kansas City, Mo.	1.60
Sand Springs, Okla.	Miami, Okla.	2.20
	Quapaw, Okla.	2.20
	Galena, Kan.	1.50
	Joplin, Mo.	1.50
	Iola, Kan.	2.40
La Harpe, Kan.	Oswego, Kan.	0.50
	Parsons, Kan.	0.50
Coffeyville, Kan.	Galena, Kan.	1.10
	Joplin, Mo.	1.00
Blackwell, Okla.	N.E.O. R.R. Stations	$1.65

Rates on Ores and Concentrates

From	To	Value of Product $5	$10	$15	$20	$25	$30	$35	$40	$50	$60	$70	$75	$80	$90	$100
		Rate														
Butte, Mont.	Anaconda, Mont.	.22	.22	.22	.22	.22	.22	.22	.22	.22	.22	.22	.22	.22	.22	.22
Butte, Mont.	Black Eagle, Mont. (a)	....	....	.....	.....	.....	.....	.....	1.01	.....	.....	.....	.....	.....	.....	1.01
Great Falls, Mont.	Helena, Mont.	....	....	1.50	....	1.69	....	1.91	....	2.36	....	....	....	....	....	2.48
Butte, Mont.	East Helena, Mont.	....	....	1.30	....	1.46	....	1.69	....	2.03	....	....	....	....	....	2.14
Paxton, Calif.	Salt Lake Smelters, Utah	....	....	....	....	....	....	....	....	5.50	6.00	6.70	....	7.40	8.10	8.80
Johannesburg, Calif.	Selby, Calif.	....	....	....	2.90	....	3.50	....	4.10	4.70	5.30	5.90	....	6.50	6.80	7.10
Johannesburg, Calif.	Humboldt, Ariz.	....	....	....	3.40	....	4.10	....	4.80	5.50	6.20	6.90	....	7.60	8.00	8.30
Pioche, Nev.	Humboldt, Ariz.	....	....	7.74	....	8.55	....	9.36	....	9.99	....	....	11.25	....	....	12.42
Creede, Colo.	Durango, Colo.	....	....	3.25	3.50	3.75	4.00	....	4.25	4.75	5.25	5.75	6.05	....	....	7.10
Ouray, Colo.	Durango, Colo.	....	....	4.30	4.80	....	5.05	....	5.50	5.90	....	6.30	....	....	....	7.70
Telluride, Colo.	Durango, Colo.	....	....	.....	4.00	....	4.30	....	4.60	5.10	5.60	6.10	....	6.50	7.00	7.50
Silverton, Colo.	Durango, Colo.	....	....	1.40	1.40	....	....	2.20	.....	.....	.....	....	....	2.30	2.55	2.80
Tyrone, N. M.	Douglas, Ariz.	....	1.30	1.60	2.30	....	2.60	....	2.90	3.20	....	....	3.80	....	....	4.40
Tyrone, N. M.	El Paso, Tex.	....	....	1.40	(c) 1.70	(c)	2.00	....	2.30	2.60	....	....	3.20	....	....	3.80
Lordsburg, N. M.	Douglas, Ariz.	....	1.00	1.30	1.70	....	2.00	....	2.30	2.60	....	....	3.20	....	....	3.80
Lordsburg, N. M.	El Paso, Tex.	....	1.00	1.30	1.80	....	2.10	....	2.40	2.70	....	....	3.30	....	....	3.90
Tombstone, Ariz.	Douglas, Ariz.	....	....	.60	1.30	....	1.60	....	1.90	2.20	....	....	2.80	....	....	3.40
Tombstone, Ariz.	El Paso, Tex.	....	1.60	1.90	....	2.90	3.20	....	3.50	3.80	....	....	4.40	....	....	5.00
Ray Junction, Ariz.	Hayden, Ariz.	....	.10	.40	1.30	....	1.60	....	1.90	2.20	....	....	2.80	....	....	3.40
Sandon, B. C. / Allenby Concentrator, B.C.	Tadanac, B. C.	1.50	1.60	1.70	1.90	2.00	2.50	....	2.60	2.90	3.40	3.50	....	3.70	3.80	3.90
Rossland, B. C.	Tadanac, B. C.	.90	.90	1.00	1.00	1.10	1.50	....	1.60	1.60	1.60	1.70	....	1.70	1.70	1.70
Rossland, B. C.	Tadanac, B. C. (b)	.30	.30	.30	.30	.50	.70	....	.80	.80	.....	.....	.....	.....	.....	.....
Republic, Wash.	Tadanac, B. C.	....	2.11	2.56	2.66	2.86	3.84	....	3.84	3.84	4.69	4.89	....	5.19	5.39	5.59

(a) Minimum of 200 tons per day.
(b) Applicable on ore only when shipped in trainload lots of not less than 10 cars and exclusive of switching charges at Rossland.
(c) Copper ore, $1.15.

From	To	Value of Ores and Concentrates $10	$15	$20	$25	$30	$35	$40	$50	$60	$70	75	$80	$90	$100
								Rate							
Burke, Idaho (a) (d)	Bradley, Idaho	....	....	....	....	....	....	.....	.....	.68	....	....	.....	.....	1.02
Burke and Wallace, Idaho	East Helena, Mont.	....	....	....	....	3.00	....	3.25	3.50	3.75	4.00	....	4.25	4.50	4.75
Sagel, Idaho	East Helena, Mont.	....	....	....	3.38	....	3.83	....	4.16	.....	....	....	.....	.....	4.84
Arizona Tunnel, Idaho	Bradley, Idaho	....	....	....	....	....	....	.....	.....	.35	....	....	.....	.....	.50
Bayview, Idaho	Bradley, Idaho	....	2.25	2.50	2.75	3.00	3.25	3.25	3.50	3.75	4.00	....	4.25	4.50	4.75
Park City, Utah	Salt Lake Smelters	1.00	1.10	1.25	....	1.50	....	1.75	....	2.00	....	....	2.25	....	2.50
Eureka, Utah	Salt Lake Smelters	1.00	1.10	1.25	....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
Tintic, Utah	Salt Lake Smelters	1.00	1.10	1.25	....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
St. Johns, Utah	Salt Lake Smelters	1.00	1.10	1.25	....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
Ophir, Utah	Salt Lake Smelters	1.00	.....	1.25	.....	1.50	....	1.75	2.00	2.25	2.50	....	2.75	3.00	3.25
Bingham, Utah	Garfield, Utah	....	.40	.....	.75	.....	....	.....	.95	.....	.....	1.10	.....	.....	1.25
Cherry Creek, Nev. (b)	Garfield, Utah (c)	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	8.10	8.60
Goldfield, Nev.	Salt Lake Smelters	....	4.15	5.10	....	5.80	....	6.50	7.20	7.90	8.60	....	9.30	10.00	10.70
Battle Mountain, Nev. (b)	Salt Lake Smelters	....	....	3.20	....	3.80	....	4.40	5.00	5.60	6.20	....	6.80	7.40	8.00
Palisade, Nev. (b)	Salt Lake Smelters	2.20	2.60	3.20	....	3.80	....	4.30	4.80	5.30	5.80	....	6.30	6.80	7.30
Mina, Nev. (b)	Salt Lake Smelters	....	....	3.60	....	4.30	....	5.00	5.70	6.40	7.10	....	7.80	8.50	9.20
Lovelock, Nev. (b)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	8.10	8.80
Golconda, Nev. (b)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	8.10	8.80
Hazen, Nev. (b)	Salt Lake Smelters	....	....	3.20	....	3.90	....	4.60	5.30	6.00	6.70	....	7.40	8.10	8.80
Tonopah, Nev.	Salt Lake Smelters	....	4.15	5.10	....	5.80	....	6.50	7.20	7.90	8.60	....	9.30	10.00	10.00
Rogerson, Idaho	Salt Lake Smelters	2.50	2.75	3.50	....	4.00	....	4.50	5.00	5.50	6.00	....	6.50	7.00	7.07
Georgetown, Colo.	Leadville, Colo.	....	....	3.50	....	3.75	....	4.00	5.00	5.00	5.80	....	5.80	5.80	5.85

(a) Minimum weight, marked capacity of car used, but not less than 80,000 lb. (b) Val. $6.00 .80c.NT; val. $7.00 .85c.NT; val. $8.00 .90c.NT; val. $9.00 .95c.NT.
(c) Minimum weight, 40,000 lb. (f) Crude ore for concentration, 30c. per ton.